International Infantry & Joint Services Small Arms Systems Symposium, Exhibition & Firing Demonstration

"Enhancing Small Arms Effectiveness in Current and Future Operations"

19 - 22 May 2008

Dallas, TX

Agenda

Tuesday, 20 May 2008

Session I: Joint Services Small Arms Synchronization Team (JSSAST)

Chair: *COL Karl Scott Flynn*, USA, Chairman, JSSAST

- *COL Robert Radcliffe*, USA
- *CAPT Pat Sullivan*, USN
- *COL Charles Beck*, USAF
- *Lt Col Tracy Tafolla*, USMC
- *CAPT Scott Genovese*, USN
- *Mr. Kevin Swenson*, Joint Non-Lethal Weapons Directorate (JNLWD)

Small Arms Section Awards Presentation

Chinn Award

Recipient: *Mr. Troy Smith*

Hiram Maxim and His Machinegun: A Great Force Harnessed to a Useful Purpose

- *Dr. Stephen Small*, JSSAP, U.S. Army, ARDEC

PM Soldier Weapons

- *Mr. Richard Audette*, Deputy, PM Soldier Weapons
- *LTC Timothy Chyma*, USA, PM Individual Weapons
- *LTC Michael Ascura*, USA, PM Crew Served Weapons

Session II: Small Arms Ammunition and Technology

Lethal Limited Range Harbor Security Ammunition

- *Mr. Stephen McFarlane*, U.S. Army, ARDEC

Effects of Small Caliber Ammunition through Intermediate Barriers

- *Mr. Jeremy Lucid*, U.S. Army, ARDEC

After Barrier Effectiveness of Small Caliber Ammunition

- *Mr. Mark Minisi*, U.S. Army, ARDEC

.50 Caliber Short Range Training Ammunition

- *Mr. John MacDougall*, General Dynamics OTS, Canada

Session III: Advancements in 40mm Munitions (Low and High Velocity);Presentations by 40mm Technology Insertion Team

Chair: *Mr. David Broden*, Broden Resource Solutions, LLC

M385A1 Composite Projectile Feasibility Study

- *Mr. Christopher Summa*

Wednesday, 21 May 2008

Keynote Address

- *Col Robert Mattes,* USAF, CTO Director, DUSD, AS&C

Session IV: JSSAP

Lightweight Small Arms Technologies Update

- *Ms. Kori Spiegel*, U.S. Army, ARDEC

The Ultimate Caliber: Myth or Reality?

- *Mr. Shawn Spickert-Fulton,* U.S. Army, ARDEC

Infantry Studies and Simulations

- *Mr. Alexander Lee,* U.S. Army, ARDEC

Joint Service Small Arms Program Applied Research Initiatives

- *Mr. John Edwards,* U.S. Army, ARDEC

JSSAP's Future Small Arms Technology Plan: The Fusion of Science and Science Fiction

- *Mr. Joel Goldman,* Chief, JSSAP, U.S. Army, ARDEC

Session V: NATO

NATO Research and Technology Organization Update

- *Mr. Mark Richter*, U.S. Marine Corps Systems Command, Quantico

NATO Infantry Weapons Standardization

- *Mr. Per Arvidsson,* FMV, Sweden

Session VI: Time for a Change – U.S. "Incremental" Small Arms Fielding: Failures and Solutions

- *Mr. Jim Schatz, Jr.,* Time for a Change Team
- *Dr. Gary Roberts*, DDS

Session VII: Industry Ammunition Producers and Technology Companies

Chair: *Mr. David, Broden,* Broden Resource Solutions, LLC

- *Mr. Steve Torma,* General Dynamics OTS
- *Mr. Dave Council*, Olin
- *Mr. Sy Wiley,* Polytech

Thursday, 22 May 2008

Keynote Address

- *Mr. Chris Grassano,* Project Manager, Maneuver Ammunition Systems

National Small Arms Center Update

- *Mr. Frank Puzycki,* U.S. Army, ARDEC

Session IX: Testing, Training and Simulation

Technical Evaluation, Operational Evaluation, Lessons Learned in Small Arms Procurement

- *Mr. Joseph Abram*, NAVSEA, Crane

Suppressing Sacred Cows

- *Mr. Graham Evenden,* System Design Evaluation, Ltd.

NDIA Strategic Initiatives

- *Mr. David Broden,* Chairman, Armaments Division; Broden Resource Solutions, LLC

Session X: Less Lethal Systems and Technology

- *Session Overview,* JNLWD
- *Human Effects and Effectiveness*, HECOE
- *Mission Payload Module*, NL Weapon System, MCSC
- *Improved Flash Bang Grenade*, SOCOM
- *Taser International*
- *Beretta/Defense Technologies*

Session XI: Weapons

Canadian Proposed Small Arms Demonstration Project

- *Mr. Gilles Pageau,* Directorate Soldier System Program Management 10-4

Advanced Thermal Management of Automatic Rifles

- *Ms. Laurie Florio*, U.S. Army, ARDEC

Implementation of the New Israeli Light Machine Gun (LMG),"The NEGEV," as a Fire Power Multiplier in the Current and Future Battlefields: Assessments & Conclusions

- *Lt Col Michael Hartman*, IDF Israel, North East Technologies, Ltd.

Experimental Performance Analysis on Recoil Pad for Reducing Firing Shock Force

- *Dr. Joon-Ho Lee,* Agency for Defense Development, Korea

Development of a Non-Lethal 12ga. Shotgun System for Use with the EM113REV

- *Mr. Kevin Adams,* U.S. Army, ARDEC ATF

Session XII: Fire Control

Fire Control Units for Thermal Weapon Sights

- *Mr. Alexander Kuhrt*, Helmut Schmidt University, Germany

Aimpoint BR8: A Fire Control System for Small Arms

- *Mr. Lennart Ljungfelt,* Aimpoint, Inc.

Real Time Fire Control Solution for Individual and Crew-Served Direct Firing Infantry Weapons: Algorithm and Implementation

- *Mr. Alexander Kuhrt,* Helmut Schmidt University, Germany

NDIA
NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

PROMOTING NATIONAL SECURITY SINCE 1919

INTERNATIONAL INFANTRY & JOINT SERVICES

SMALL ARMS SYSTEMS SYMPOSIUM, EXHIBITION & FIRING DEMONSTRATION

"Enhancing Small Arms Effectiveness in Current and Future Operations"

HIGHLIGHTS

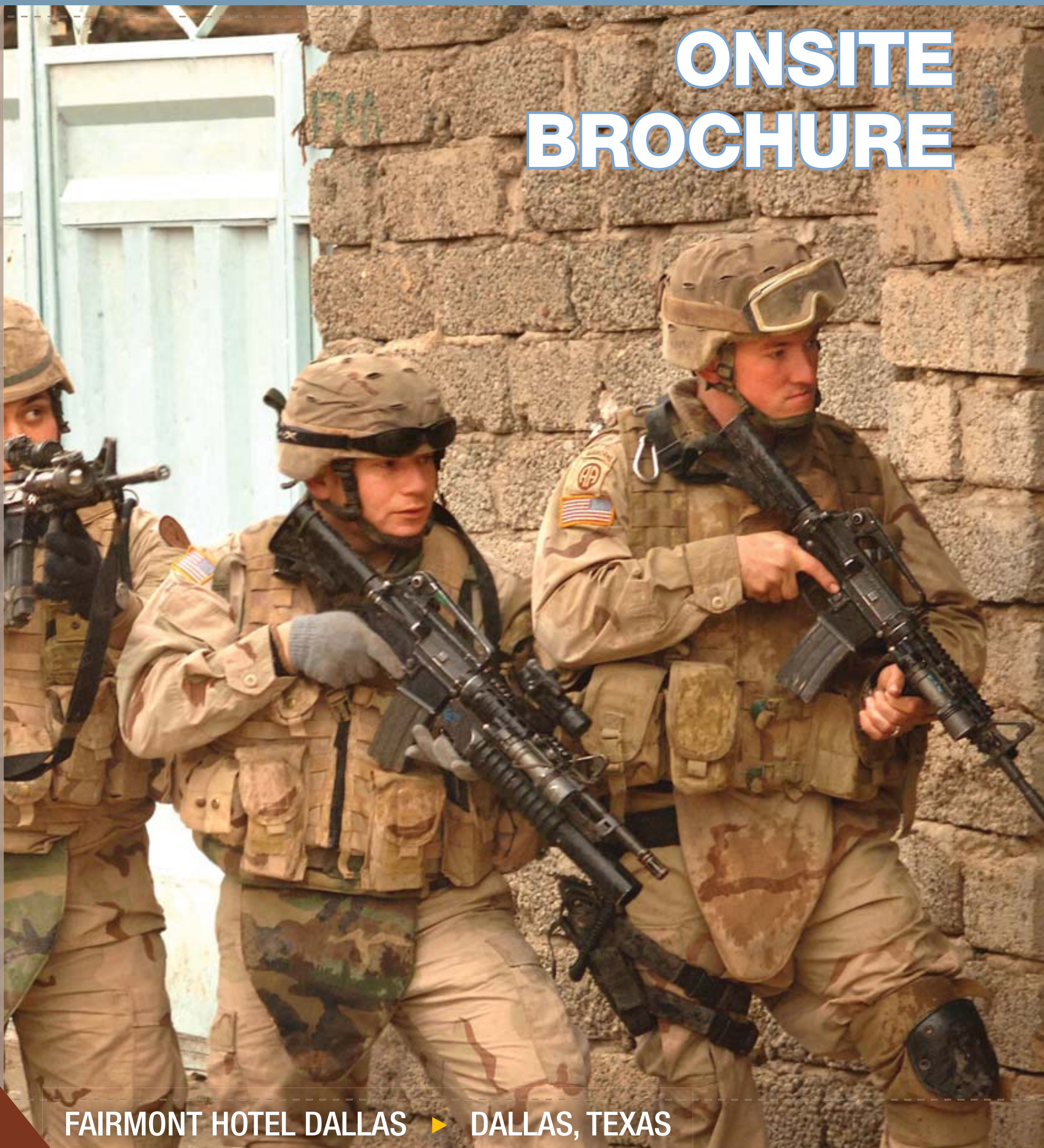
Keynote Speakers include:

- Hon James R. Ambrose, former Under Secretary of the Army
- Col Robert Mattes, USAF CTO Director, DUSD, AS&C
- Mr. Chris Grassano, Project Manager, Maneuver Ammunition Systems

- The first James R. Ambrose Award, named for former Under Secretary of the Army, will be presented on Tuesday morning, in addition to the George Chinn and Carlos Hathcock Awards

- The Firing Demonstration will be held on Wednesday evening at Tac Pro Shooting Center

ONSITE BROCHURE



MAY 19-22, 2008

FAIRMONT HOTEL DALLAS ▸ DALLAS, TEXAS

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EVENT #8610

INTERNATIONAL INFANTRY & JOINT SERVICES
SMALL ARMS SYSTEMS SYMPOSIUM, EXHIBITION & FIRING DEMONSTRATION
MAY 19-22, 2008 ▸ DALLAS, TEXAS

OBJECTIVE

Facing terrorist forces from MOUT to the open battlefield, American forces – both military and law enforcement alike – require the best equipment available. Only through the efforts of government and industry working together on a wide range of technology focus areas will the tools necessary to support our soldiers, sailors, airmen and marines now and in the future be realized. These focus areas range from incremental enhancements to fielded legacy small arms systems to enabling technologies, such as fire control improvements, use of robotics and digitization of small arms systems on the battlefield, to name a few. This symposium seeks to bring together government and industry, manufacturers and users to support this objective for the military and law enforcement communities.

AMBROSE AWARD

The Ambrose Award was established and is presented periodically to recognize an Industrial Firm which, in the opinion of the Small Arms Division Executive Board, has made outstanding contributions to the field of small arms systems. An outstanding contribution is characterized by exemplary commitment and contribution to the Armed Forces by delivering superior materiel that meets required operational capabilities and supports a high level of force readiness in the conduct of warfighting activities or homeland defense. Such contributions may be shown through a record of continual demonstration of emerging technologies, development of products and systems, establishment of enhanced production capabilities and integration of innovative weapons systems and supporting products and services required by the DoD and Allied countries. Such contributions would be easily recognized as "excellence" in industry leadership and responsiveness in cases where national security priorities require attention to meet urgent needs in either peace or war time.

This award is named in honor of former Under Secretary of the Army, James R. Ambrose, because of his recognition of the value and contribution of industry in meeting the needs of our national defense. This was made unmistakably clear during his tenure from 1981-1988 as Under Secretary of the Army during the Presidency of Ronald Reagan. He was a major force in the post Vietnam modernization of all small arms weaponry where new and improved versions of the M16, M249 and M9 were purchased in large quantities as a result of industry competitions. Secretary Ambrose was a strong supporter of investing in the Future Rifle Program, later known as the Advanced Combat Rifle (ACR) Program. His emphasis on the need for competition could not be clearer here, as there were as many as six contractor systems in various phases of the program and 4 firms ultimately participated in the 9-month long ACR Field Experiment, the premier rifle evaluation of all time. For his support of small arms development and procurement and his strong emphasis and actions in involving industry at every step of the way, the NDIA Small Arms Division believes it entirely appropriate to name this award in his honor.

ATTIRE

Appropriate dress for this symposium is business casual for civilians and Class B uniform or uniform of the day for military personnel.

ID BADGES

During symposium registration and check-in, each attendee will be issued an identification badge. Badges must be worn at all symposium functions.

PROCEEDINGS

Proceedings will be available on the web through the Defense Technical Information Center (DTIC) one to two weeks after the symposium. You will receive notification via e-mail once the proceedings are available to download/print/view.

CONTACTS

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Exhibits Manager
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PREVIOUS RECIPIENTS CHINN AWARD

Thomas E. Cosgrove, 1988
James Ackley, 1989
John S. Wood, Jr., 1990
Roderic A. Spies, 1991
Edward C. Ezell, 1993
Richard E. Brown, 1994
Joseph Unterkofler, 1995
C. Reed Knight, Jr., 1996
Robert A. Trifiletti, 1997
George E. Kontis, 1998
Vernon E. Shisler, 1999
Salvatore A. Fanelli, 2000
L. James Sullivan, 2001
Ernst Mauch, 2002
Phil Baker, 2003
Georges Chauveheid, 2003
Ronnie Barrett, 2004
Richard Audette, 2005
Richard Swan, 2006
William Dittrich, 2007

PREVIOUS RECIPIENTS HATHCOCK AWARD

Charles B. Mawhinney, 2000
William Bartholomew, 2001
Jim Owens, 2000
Larry Vickers, 2003
Steve Holland, 2004
Christopher Mitternight, 2005
Allen Boothby, 2006
American Snipers Organization, 2007

CHINN AWARD

The Chinn Award is presented annually to honor a government or industry individual who, in the opinion of the Small Arms Division Executive Board, has made significant contributions to the field of small arms and/or infantry weapons systems. A significant contribution is considered to be a creative invention, new design or innovative concept in small arms weapons, ammunition or ancillary equipment that provides an advancement in the state-of-the art or capability enhancement that clearly benefits the warfighting or general military capability of the U.S. The Chinn Award may also be conferred as recognition to an individual who has performed sustained superior service in a career field of science, engineering, test and evaluation, manufacturing program management, academic study and research, publishing or maintenance relating to military small arms or infantry weapons.

The Chinn Award is named in honor of Lieutenant Colonel George M. Chinn, USMC, a career Marine who dedicated his life to the study, development and refinement of machine gun mechanisms. LtCol Chinn is remembered for his work as a gun designer and for having compiled a five volume reference work entitled, "The Machine Gun."

HATHCOCK AWARD

The Hathcock Award is presented to recognize an individual who, in the opinion of the Small Arms Division Executive Board, has made significant contributions in operational employment and tactics of small arms weapons systems which have impacted the readiness and capabilities of the U.S. military or law enforcement. A significant contribution is considered to be a superior performance of duties in an operational environment or the development of tactics or training.

The Hathcock Award is named in honor of Gunnery Sergeant Carlos N. Hathcock, II, USMC, a career Marine who dedicated his life to the service of this country in both the military and law enforcement communities. He was honest, tactful, considerate, courageous, quietly proud and determined in all things and all places from the range to the battlefield. "The Gunny" not only distinguished himself in combat as a scout-sniper, but also as a competitive marksman and trainer. In his capacity as a trainer, he not only significantly impacted the current United States Marine Corps Scout-Sniper Program, but also influenced the sniper programs of the other military services and similar law enforcement programs nationwide.

SESSION I CHAIR

COL Karl Scott Flynn, USA,
Chairman, JSSAST

AWARDS PRESENTATION

Join your colleagues to honor the Chinn, Hathcock and Ambrose award winners on Tuesday morning.

Hon James R. Ambrose, former Under Secretary of the Army, will be in attendance to present the first James R. Ambrose Award.

MONDAY, MAY 19, 2008

9:00 AM - 6:30 PM	Registration Open – *International Ballroom Foyer*
5:00 PM - 6:30 PM	Welcome Reception – *Regency Ballroom* Exhibit Hall Open

TUESDAY, MAY 20, 2008

7:00 AM - 6:30 PM	Registration Open – *International Ballroom Foyer* Exhibit Hall Open – *Regency Ballroom*
7:00 AM - 7:50 AM	Continental Breakfast in Exhibit Hall – *Regency Ballroom*
7:50 AM	Welcome and Administrative Announcements – *International Ballroom* ▸ Mr. Sam Campagna, Director, Operations, NDIA ▸ Mr. Brian Berger, Chairman, Small Arms Committee; Vice President and General Manager, General Dynamics OTS Simunition Operations
8:00 AM	Keynote Address ▸ Hon James R. Ambrose, former Under Secretary of the Army
8:30 AM	Session I: Joint Services Small Arms Synchronization Team (JSSAST) ▸ COL Robert Radcliffe, USA ▸ CAPT Pat Sullivan, USN ▸ Col Charles Beck, USAF ▸ LtCol Tracy Tafolla, USMC ▸ CAPT Scott Genovese, USN ▸ COL Kevin Noonan, USA, SOCOM ▸ Mr. Kevin Swenson, Joint Non-Lethal Weapons Directorate (JNLWD)
10:00 AM	Break in Exhibit Hall – *Regency Ballroom*
10:30 AM	Guest Speaker ▸ Mr. Bryan O'Leary, Office of Senator Coburn (R-OK)
11:00 AM	Small Arms Section Awards Presentation Chinn Award Recipient: Mr. Troy Smith Presented by: Mr. Jim Schatz Hathcock Award Recipient: SSA J. Buford Boone Presented by: Mr. Sal Fanelli and Mr. Bill Kozacek Ambrose Award Recipient: St. Marks Powder Presented by: Hon James R. Ambrose, Mr. Brian Berger and Mr. Charles Buxton

11:30 AM	Luncheon – *Gold & Parisian*
12:20 PM	Hiram Maxim and His Machinegun: A Great Force Harnessed to a Useful Purpose ▸ Dr. Stephen Small, JSSAP, U.S. Army, ARDEC
12:40 PM	PM Soldier Weapons ▸ Mr. Richard Audette, Deputy, PM Soldier Weapons ▸ LTC Timothy Chyma, USA, PM Individual Weapons ▸ LTC Michael Ascura, USA, PM Crew Served Weapons
1:10 PM	Session II: Small Arms Ammunition and Technology Lethal Limited Range Harbor Security Ammunition ▸ Mr. Stephen McFarlane, U.S. Army, ARDEC Effects of Small Caliber Ammunition through Intermediate Barriers ▸ Mr. Jeremy Lucid, U.S. Army, ARDEC After Barrier Effectiveness of Small Caliber Ammunition ▸ Mr. Mark Minisi, U.S. Army, ARDEC Lightweight Small Caliber Ammunition Update ▸ Mr. George Feghali, General Dynamics OTS, Canada Development of a Viable Alternate Accuracy Requirement for 7.62mm Sniper ▸ Mr. Eli Golden, U.S. Army, ARDEC ▸ Mrs. Susan Polinski, U.S. Army, ARDEC .50 Caliber Short Range Training Ammunition ▸ Mr. John MacDougall, General Dynamics OTS, Canada Environmentally Friendly Primers for Small Caliber Ammunition ▸ Dr. Rao Yalamanchili, U.S. Army, REDCOM ARDEC
2:40 PM	Session III: Advancements in 40mm Munitions (Low and High Velocity); Presentations by 40mm Technology Insertion Team M385A1 Composite Projectile Feasibility Study ▸ Mr. Christopher Summa Development of M16A2 Pivoting Coupling ▸ Mr. Matthew Millar Electronics and Sensors in 40mm Low Velocity Grenade Ammo ▸ Mr. Jason Wasserman Producibility Improvements of 40mm High and Low Velocity Liners ▸ Mr. Adam Sorchini Center of Mass Changes During Arming of 40mm Fuzes ▸ Mr. Adam Jacob 40mm Day/Night Practice Cartridge for MK13/XM320/M203 Grenade Launchers ▸ Mr. Peter Martin for Mr. Fred Fitzsimmons ▸ Mr. James Grassi ▸ Ms. Melissa Wanner
3:30 PM	Break in Exhibit Hall – *Regency Ballroom*
5:00 PM - 6:30 PM	Reception in Exhibit Hall – *Regency Ballroom*

SESSION II CHAIR

Mr. James Taylor, ATK, Lake City Army Ammunition Plant (LCAAP)

SESSION III CHAIR

Mr. David Broden, Broden Resource Solutions, LLC

WEDNESDAY, MAY 21, 2008

7:00 AM - 1:30 PM	Exhibit Hall Open – *Regency Ballroom*
7:00 AM - 2:30 PM	Registration Open – *International Ballroom Foyer*
7:00 AM - 7:45 AM	Continental Breakfast in Exhibit Hall – *Regency Ballroom*
7:45 AM	Welcome and Administrative Announcements – *International Ballroom* ▸ Mr. Sam Campagna, Director, Operations, NDIA ▸ Mr. Brian Berger, Chairman, Small Arms Committee; Vice President and General Manager, General Dynamics OTS Simunition Operations
7:50 AM	Keynote Address ▸ Col Robert Mattes, USAF, CTO Director, DUSD, AS&C
8:10 AM	**Session IV: JSSAP**
8:10 AM	Lightweight Small Arms Technologies Update ▸ Ms. Kori Spiegel, U.S. Army, ARDEC
8:30 AM	The Ultimate Caliber: Myth or Reality? ▸ Mr. Shawn Spickert-Fulton, U.S. Army, ARDEC
8:50 AM	Infantry Studies and Simulations ▸ Mr. Alexander Lee, U.S. Army, ARDEC
9:10 AM	Joint Service Small Arms Program Applied Research Initiatives ▸ Mr. John Edwards, U.S. Army, ARDEC
9:30 AM	JSSAP's Future Small Arms Technology Plan: The Fusion of Science and Science Fiction ▸ Mr. Joel Goldman, Chief, JSSAP, U.S. Army, ARDEC
9:50 AM	Break in Exhibit Hall – *Regency Ballroom*
10:20 AM	**Session V: NATO**
10:20 AM	NATO Land Capabilities Group (LCG) 1: Dismounted Soldier ▸ LTC Mike Bodner, DND Canada, Chairman, NATO LCG 1, Directorate of Land Requirements (DLR)
10:30 AM	NATO Research and Technology Organization Update ▸ Mr. Mark Richter, U.S. Marine Corps Systems Command, Quantico
10:45 AM	NATO Infantry Weapons Standardization ▸ Mr. Per Arvidsson, FMV, Sweden
11:00 AM	Topical Group 3: Non-Lethal Capabilities Update ▸ Ms. Liliana McShea, U.S. Army, ARDEC
11:20 AM	**Session VI: Time for a Change – U.S. "Incremental" Small Arms Fielding: Failures and Solutions** ▸ Mr. Jim Schatz, Jr., Time for a Change Team ▸ Dr. Gary Roberts, DDS
12:20 PM	Luncheon – *Gold & Parisian*
1:30 PM	Exhibit Hall Closes

SESSION IV CHAIR

Mr. Joel Goldman, Chief, JSSAP, U.S. Army, ARDEC

SESSION V CHAIR

LTC Mike Bodner, DND Canada, Chairman, NATO LCG 1, Directorate of Land Requirements (DLR)

1:30 PM	**Session VII: Industry Ammunition Producers and Technology Companies** ▸ Mr. Keith Enlow, ATK Lake City ▸ Mr. Steve Torma, General Dynamics OTS ▸ Mr. Bruce Webb, Nammo USA ▸ Mr. Alan Serven, Remington ▸ Mr. Dave Council, Olin ▸ Mr. John MacDougall, General Dynamics OTS, Canada ▸ Mr. Paul Shipley, Textron-AAI ▸ Mr. Nick Malkovich, Mac Ammo ▸ Mr. Sy Wiley, Polytech
2:30 PM	Board Buses and Depart for Contractor Firing Demonstration – *Tac Pro Shooting Center*
4:30 PM	**Session VIII: Contractor Firing Demonstration**
5:30 PM	BBQ Dinner Buffet – *Tac Pro Shooting Center*
7:00 PM	Buses Start Returning to Fairmont Hotel Departures at 7:00 PM, 7:30 PM, 8:00 PM and 8:30 PM

SESSION VII CHAIR

Mr. David Broden, Broden Resource Solutions, LLC

SESSION VIII CHAIR

Mr. Sal Fanelli, U.S. Marine Corps Infantry Weapons

THURSDAY, MAY 22, 2008

7:30 AM - 4:00 PM	Registration Open – *International Ballroom Foyer*
7:30 AM - 8:20 AM	Continental Breakfast – *International Ballroom Foyer*
8:20 AM	Welcome and Administrative Announcements – *International Ballroom* ▸ Mr. Sam Campagna, Director, Operations, NDIA ▸ Mr. Brian Berger, Chairman, Small Arms Committee; Vice President and General Manager, General Dynamics OTS Simunition Operations
8:30 AM	Keynote Address ▸ Mr. Chris Grassano, Project Manager, Maneuver Ammunition Systems
9:00 AM	National Small Arms Center Update ▸ Mr. Frank Puzycki, U.S. Army, ARDEC
9:30 AM	**Session IX: Testing, Training and Simulation**
9:30 AM	Technical Evaluation, Operational Evaluation, Lessons Learned in Small Arms Procurement ▸ Mr. Joseph Abram, NAVSEA, Crane
9:50 AM	Suppressing Sacred Cows ▸ Mr. Graham Evenden, System Design Evaluation, Ltd.
10:10 AM	NDIA Strategic Initiatives ▸ Mr. David Broden, Chairman, Armaments Division; Broden Resource Solutions, LLC
10:30 AM	Break – *International Ballroom Foyer*

SESSION IX CHAIR

Ms. Liliana McShea, U.S. Army, ARDEC

SESSION X CHAIR

Mr. Kevin Swenson, JNLWD, Quantico

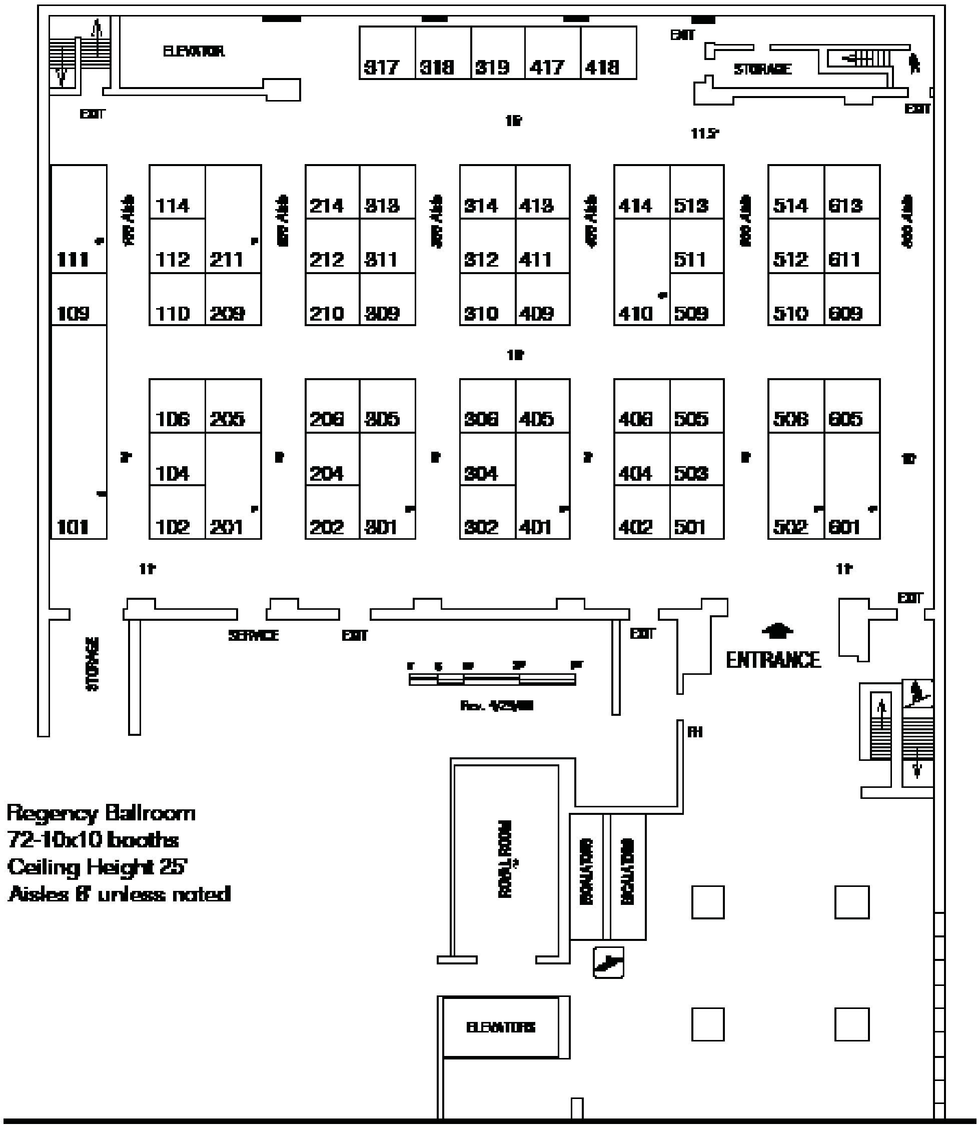
SESSION XII CHAIR

Mr. John Edwards, U.S. Army, ARDEC

10:50 AM	**Session X: Less Lethal Systems and Technology**
10:50 AM	Session Overview, JNLWD
11:00 AM	Human Effects and Effectiveness, HECOE
11:20 AM	Mission Payload Module, NL Weapon System, MCSC
11:40 AM	Improved Flash Bang Grenade, SOCOM
12:00 PM	Taser International
12:20 PM	Beretta/Defense Technologies
12:30 PM	Luncheon – *Venitian*
1:30 PM	**Session XI: Weapons**
1:30 PM	Canadian Proposed Small Arms Demonstration Project ▸ Mr. Gilles Pageau, Directorate Soldier System Program Management 10-4
1:50 PM	Advanced Thermal Management of Automatic Rifles ▸ Ms. Laurie Florio, U.S. Army, ARDEC
2:30 PM	Break – *International Ballroom Foyer*
2:40 PM	Implementation of the New Israeli Light Machine Gun (LMG), “The NEGEV,” as a Fire Power Multiplier in the Current and Future Battlefields: Assessments & Conclusions ▸ LtCol Michael Hartman, IDF Israel, North East Technologies, Ltd.
3:00 PM	Experimental Performance Analysis on Recoil Pad for Reducing Firing Shock Force ▸ Dr. Joon-Ho Lee, Agency for Defense Development, Korea
3:20 PM	Development of a Non-Lethal 12ga. Shotgun System for Use with the EM113REV ▸ Mr. Kevin Adams, U.S. Army, ARDEC ATF
3:40 PM	**Session XII: Fire Control**
3:40 PM	Fire Control Units for Thermal Weapon Sights ▸ Mr. Alexander Kuhrt, Helmut Schmidt University, Germany
4:00 PM	Aimpoint BR8: A Fire Control System for Small Arms ▸ Mr. Lennart Ljungfelt, Aimpoint, Inc.
4:20 PM	Real Time Tire Control Solution for Individual and Crew-Served Direct Firing Infantry Weapons: Algorithm and Implementation ▸ Mr. Alexander Kuhrt, Helmut Schmidt University, Germany
4:40 PM	Closing Remarks Conference Concludes

Thank you for your participation!
Pease return your survey to the NDIA Staff.

EXHIBIT FLOOR PLAN



FIRING DEMONSTRATION COMPANIES

- Aimpoint, Inc. – *weapon optics*
- Ashbury International Group, Inc. – *sniper rifle systems*
- ATK – *ammunition donation*
- Colt Defense, LLC – *assault rifles*
- Command Arms – *small arms accessories*
- Engel Ballistics Research – *specialty and subsonic ammunition*
- FNH USA, LLC – *infantry weapons*
- GLOCK – *handguns*
- Inland Technologies, Inc. – *weapons cleaning system*
- La Rue Tactical – *portable targeting system*
- Less-Lethal – *less-lethal devices*
- Long Mountain Outfitters – *foreign weapons, mounts, accessories*
- Mac Ammo – *small arms ammunition*
- Magpul Inds. Corporation – *small arms, assault rifles, accessories*
- Metal Storm, Inc. – *multi shot weapon systems*
- MILKOR USA – *M32 Grenade Launcher*
- NeTech – *infantry assault rifles*
- NLight/Laser Devices – *optical distractor*
- Pierce Targets – *portable targeting system*
- Remington Arms – *sniper rifle systems*
- Smith & Wesson – *handguns*
- Tally/Nammo – *shoulder launched ordnance*
- Trijicon, Inc. – *weapon optics*
- TSSI – *weapon optics*
- Wilcox Industries – *night vision equipment*

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- St. Marks Powder
- Trijicon, Inc.

SAVE THE DATE

MAY 18-21, 2009
LAS VEGAS

WE LOOK FORWARD TO SEEING YOU NEXT YEAR

ATK

ATK is a premier aerospace and defense company with $4.1 billion in annual sales, over 17,000 employees and operations in 21 states.

ATK Armament Systems Group is the world's largest manufacturer of small and medium-caliber ammunition. Our military and commercial ammunition product portfolio spans a broad range, from 5.56mm through .50 caliber for use in handguns, shotguns and rifles. We also manufacture 20mm, 25mm and 30mm rounds for air, land and sea platforms, as well as large caliber ammunition for main battle tanks. We are developing enhanced tactical ammunition including air bursting munitions, next-generation energetics and advanced propellants that will increase performance and lethality.

ATK is also the world's top producer of Bushmaster medium-caliber chain gun systems for ground combat, naval and air armament applications. ATK produces the M242 25mm cannon for the Bradley Fighting Vehicle, the MK44 30/40mm cannon selected by the U.S. Marine Corps' for the Expeditionary Fighting Vehicle and the 30mm M230 cannon for the AH-64 Apache and AH-64D Apache Longbow helicopters.

Building on the capabilities of our core ammunition and rocket motor businesses, ATK is developing several breakthrough advanced weapon systems, such as the U.S. Navy's Advanced Anti-Radiation Guided Missile (AARGM) and the U.S. Army's Precision Guidance Kit (PGK), Spider munition and Individual Airburst Weapon System (IAWS). Using state-of-the-art guidance, navigation and control systems, targeting systems, high-energy propellants and advanced warheads, ATK is developing weapons that will fly farther, faster and strike targets with unprecedented precision and lethality at affordable procurement cost.

ATK is the world leader in the design, development and production of solid rocket propulsion systems for space, strategic-missile defense and tactical applications. Our tactical rocket motor portfolio includes propulsion systems for air-to-air, air-to-surface, surface-to-air and surface-to-surface missiles. Additional ATK news and information can be found at www.atk.com.



BULLDOG EQUIPMENT

Bulldog Equipment designs and manufactures custom equipment for the U.S. military. Our solutions are based upon the needs of the soldier. Our goal is to offer products that are mission-critical and to assure the customer that we will provide the finest equipment. All of our equipment is made in the USA and constructed with all-American components.

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Technical Evaluation, Operational Evaluation, Lessons Learned in Small Arms Procurement

Joe Abram
Small Arms Weapons Division
Joint Weapons Engineering Branch
SOF weapons Section

Introduction

- Operational Acceptance, as a requirement, is the best way to assure the product is “Mission Acceptable”. Our latest weapon systems (MK16, MK17, and MK13) had a strong user focus to allow multiple modifications to the design during various testing scenarios, thus ensuring the weapon system is the best it can be.

- The old way of only testing weapons in a laboratory environment has taken a back seat. As the value of operational testing becomes more familiar, we must learn to attain technical data from operational testing.

Test Plan

- Test Phase I
  - Down select/Safety
- Test Phase II
  - User Assessment/Design Development
- Test Phase III
  - Pre-Operational Test/Design Prove-out
- Test Phase IV
  - Operational Testing/Final Design Review

Phase I

- Source Selection Testing
  - Go/No-Go type testing
    - Does it meet minimum requirements of the solicitation?
  - Safety testing
    - Does it meet the safety requirements to allow use by the operators?
  - User Assessment
    - Operational evaluation to assist in down select.

Major Components (Go/No-Go)

MK16

MK13 Ancillary Stock

Accessories/Cleaning Kit

MK17

MK13 w/Trigger Assembly

Magazines

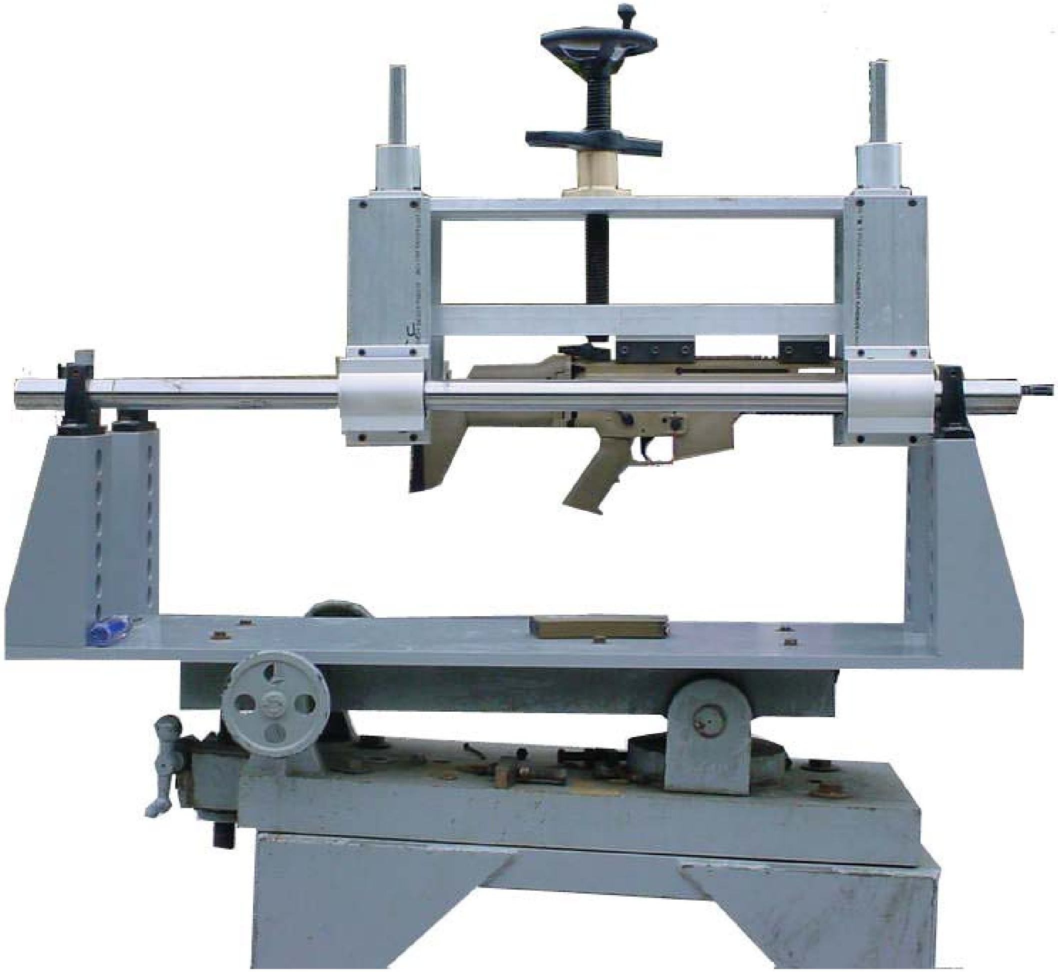
Suppressor

Fire Control Unit

Bipod

BFA

Accuracy (Go/No-Go)



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Drain Time (Safety)

c-3-shot2

User Assessment

Conducted at Camp Pendleton, Camp Billy Machen, and San Clemente Island

Source Selection

- Go/No-Go testing was the first cut in the Source Selection Process.

- Vendors passing the Go/No-Go testing proceeded to Safety Testing to allow operators to complete an Early User Assessment of all the weapons.

- After completing the Early User Assessment by the Operators, the program was reduced to one vendor by the Source Selection Committee.

Engineering Review

•Following the Source Selection, an engineering review was conducted at the vendor facility. (Operators in direct contact with design team.)

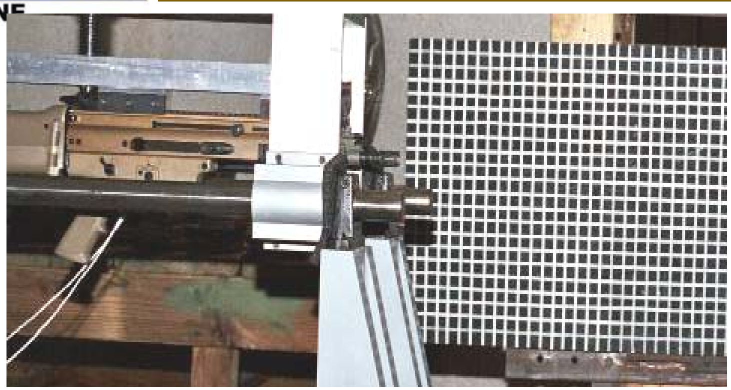
•Vendor’s project team met with Contracting Representatives, Program management, and Operators.

•Meeting was conducted to expedite the weapon development.

•Results from this review were implemented in the weapon design and samples were delivered for further testing/development.

Phase II

- Prepare for Milestone C Decision
  - Technical testing
    - NAVSEA CRANE
    - ARMY ARDEC
    - NATICK
    - FN HERSTAL
  - Pre-Operational Assessment
    - Camp Billy Machen
    - San Clemente Island
    - Camp Pendelton



Technical Testing

Conducted at NSWC Crane, IN

Environmental Technical Testing

Conducted at US Army ARDEC, Picatinny Arsenal, NJ

JUMP CERTIFICATION

Conducted at NATICK

Technical Testing

Conducted at FN HERSTAL

Pre-Operational Assessment

Conducted at Camp Pendleton, Camp Billy Machen

& San Clemente Island, CA

MILESTONE C

- Milestone C was achieved at the end of Phase II allowing the program to progress to Phase III.

Phase III

- Prepare for Operational Testing
  - Additional testing used to verify any changes made prior to the Operational Test.
    - Camp Pendleton
    - Camp Billy Machen
    - NAVSEA CRANE

Operational Assessment

Conducted at Camp Pendleton & Camp Billy Machen, CA

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Operation Assessment

Conducted at NAVSEA CRANE

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Phase IV

- Operational Testing
  - Final Testing Prior to Fielding
    - Fort Benning-Rangers
    - Camp Lejuene-MARSOC
    - Stennis Space Center-NSW
    - MCMWTC-NSW/SF
    - Avon Park

Operational Testing – Urban

Conducted at Ft. Benning, GA & Ft. Knox, KY

Operational Testing – Rural/Maritime

Conducted at Camp Lejuene, NC

Operational Testing – Jungle/Maritime

Conducted at Stennis Space Center, MS

Operational Testing – Mountain/Cold

Conducted at MCMWTC, Bridgeport, CA

Final Changes

- After conclusion of the many phases of operational testing, Engineering Changes were requested to satisfy the needs of the operator community.
- The design Engineering Change Proposals are implemented and tested in a laboratory environment.
- When changes are approved, a final test was conducted to confirm the changes in an operational environment.

Closing

- Crane has done as much as can be accomplished to pull technical data from operational testing. We have combined developmental and operational testing to support technical testing goals. We have used this data to set the standards on the weapon for such things as parts replacement and service life in real world situations.
- This allows us to attain the data we have always needed, but now the data is attained from real world situations with operators, giving the data validity during use.

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NATO Infantry Weapons Standardization

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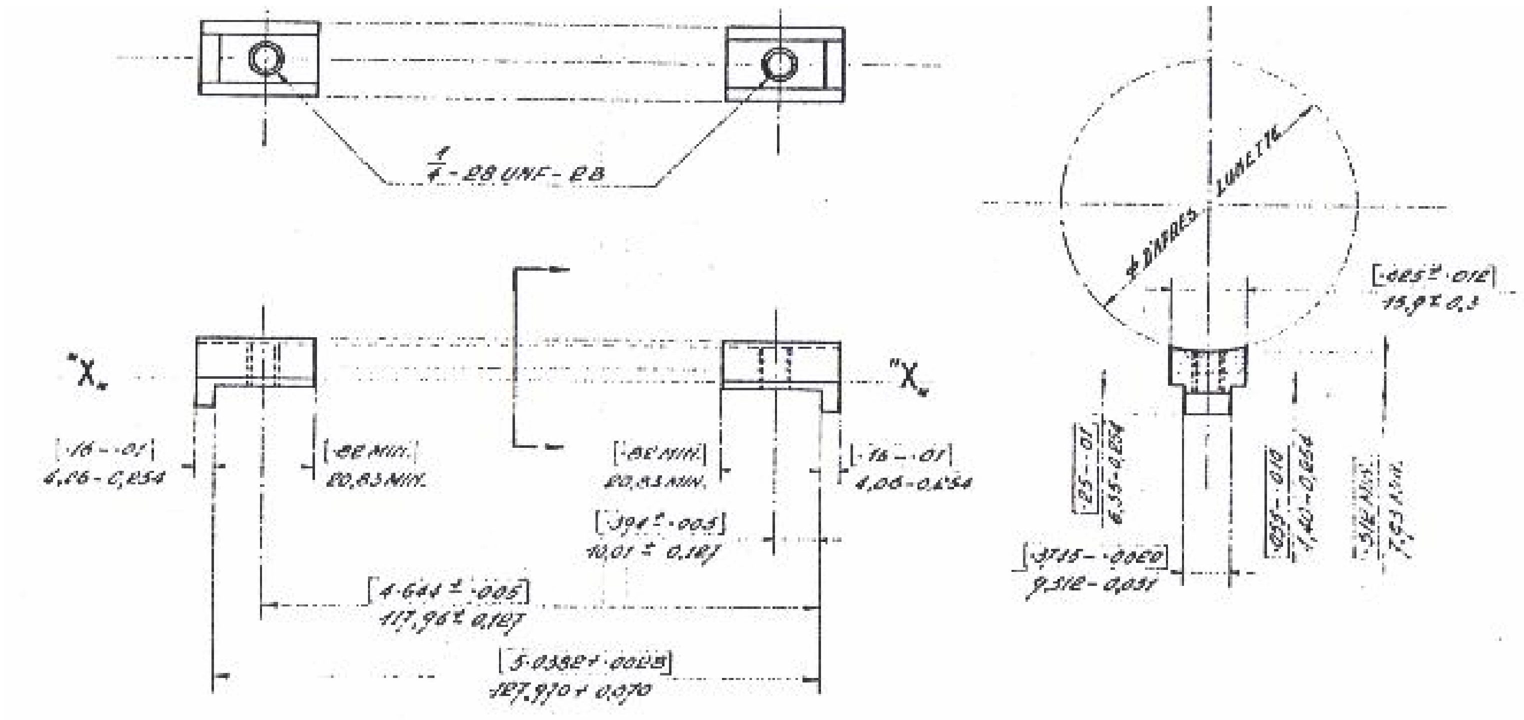
Future NATO small arms?

The first NATO infantry weapons STANAG



STANAG 2324 on “Rules governing the interchangeability of securing and holding devices for infra-red scopes on carbines, rifles and light machine guns” from 1961, cancelled in 1979.

History of 5.56 NATO

- In 1970 NATO decided to try to standardize a common rifle and a second caliber to 7.62mm.
- During 1976-1979 they therefore performed mutual tests with rifles and ammunition in West Germany and Canada.
- The calibers tested were:
  - 5.56mm rounds with increased penetration from USA and BEL.
  - GBR 4.85mm round.
  - DEU 4.7mm caseless round.

USA	GBR	DEU	BEL
5.56	4.85	4.7	5.56
XM777			SS109

NATO rifle and ammunition trials 1976-1979






Country	Weapon	Caliber (mm)	Ammunition
Germany	G11	4.7	4.7 caseless
United Kingdom	4.85 IW	4.85	4.85
Belgium	FNC	5.56	SS109
Netherlands	MN 1 (Stoner 63)	5.56	M193
United States	M16A1	5.56	XM777
France	FAMAS	5.56	F1 brass and steel cased (M193 type)
United States (control)	M16A1	5.56	M193
Germany (control)	G3	7.62	7.62 NATO

The results

- No weapon could be agreed upon.
- Some were in their prototype status.
- The BEL SS109 round was found to be the best, and was standardized as NATO’s second rifle caliber in 1980.

Proposed standardization

There is no NATO rifle!

- During the tests the US M16A1 was a control weapon.
- You can often see reference to:
  - NATO magazine.
  - NATO flash hider.
  - NATO bayonet.
- There is currently no such thing!

NATO Nominated Weapons

- NNW's are used as reference when new ammunition is standardized.
- As of 2008 the 5.56mm rifles are:
  - FNC, Belgium
  - G36, Germany
  - AR70/90, Italy
  - L85A2, United Kingdom
  - M16A2, USA
- A new NNW must work with all qualified 5.56mm ammunition designs.

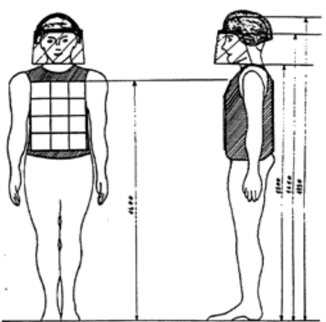
5.56mm NATO Ball Qualified Designs

NATO Design Number	Sponsoring Country	Head Stamp Initials	Publication Date	Manufacturer
AC/225-111A	USA	LC	30/06/1987	GOCO, Lake City, USA
		WCC		Olin Winchester USA
		TAA		205th Arsenal, Taiwan
AC/116-112A	BEL	FNB	14/11/1989	Fabrique Nationale, Belgium
AC/225-113A	ITA	SMI	12/04/1990	Europa Metalli, Italy
AC/225-114A	GBR	RG	14/08/1995	Royal Ordnance, United Kingdom
AC/225-116A	BEL	FNB	16/11/1995	Giat Industrie, France
AC/225-117A	NLD	HP	15/05/1996	Hirtenberger, Austria
AC/225-118A	CAN	IVI	17/01/1997	GD-OTS, Canada
AC/225-120A	POR	FNM	31/08/1998	Indep, Portugal
AC/225-122A	ITA	GFL	11/01/1999	Fiocchi, Italy
AC/225-124A	GBR	RG	24/02/1999	Royal Ordnance, United Kingdom
AC/225-125A	DEU	DAG	10/03/2000	RUAG, Germany
		MEN		MEN, Germany
AC/225-126A	BEL, FRA	IMI	10/03/2000	IMI, Israel
AC/225-127A	SPA	SB	26/09/2000	Santa Barbara, Spain
AC/225-128A	NOR	CG	6/07/2004	NAMMO, Sweden
AC/225-130A	LIT	GGG	26/05/2005	GGG, Lithuania
AC/225-132A	GBR	RG	27/01/2006	BAE Systems Radway Green, United Kingdom
AC/225-133A	GBR	RG	30/01/2006	BAE Systems Radway Green, United Kingdom

CRISAT

- During the early nineties an extensive work was performed by LG/3 (then named Panel III) called "Program for Collaborative Research Into Small Arms Technology" (CRISAT).
- Seven areas were studied.
- A report was published in 1994.
- The results were used to develop STANAG's and the D/7 document "Infantry Small Arms Post-2000" (NATO AC/225(LG/3)D/7).

US: Technology Area 1: Target Definition
UK: Technology Area 2: Terminal Effects
FR: Technology Area 3: Target Acquisition
US: Technology Area 4: Materials
GE: Technology Area 5: Propellants
US: Technology Area 8: Power & Electronics Systems
UK: Technology Area 9: Analysis of Effectiveness



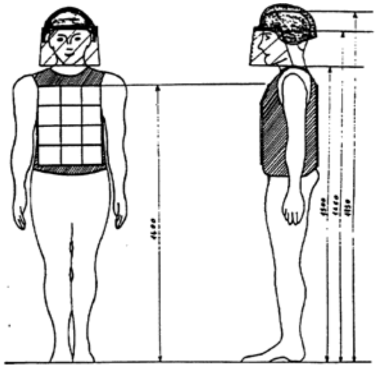
STANAG 4512
Dismounted personnel target

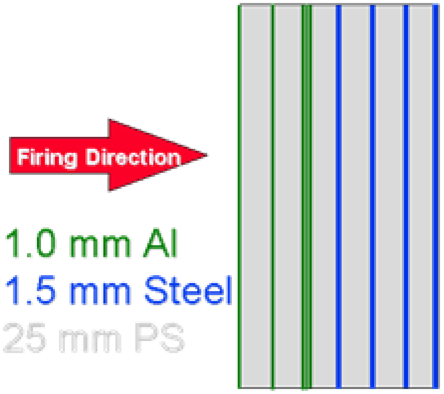
LCG/1 STANAG's

STANAG	Title	Prom. Date
2310	Small Arms Ammo. (7.62mm)	11-76
2329	Links for 7.62mm Ammo (AOP-3)	04-82
4090	Small Arms Ammo. (9mm)	04-82
4172	Small Arms Ammo (5.56mm)	05-93
4173	25mm x 137mm AFV Cannon Ammo	04-86
4383	Small Arms Ammo. (12.7mm)	07-01
4403	Standard 40mm Grenades - High Velocity	
4498	Unarmoured Vehicles, Helicopters & Field Fortification Targets	04-04
4512	Dismounted Personnel Targets	04-04
4513	Incapacitation & Suppression	04-04
4536	Representative Building Targets	04-04
4619	Electrical connectivity standards for dismounted soldier systems	

STANAG 4512 dismounted personnel targets

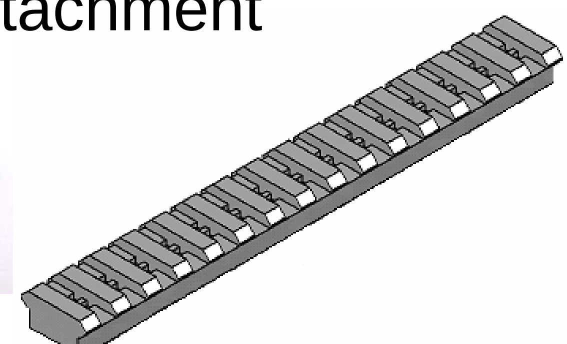
- A “NATO protected” man is defined, but there is a lack of a ”NATO unprotected man”.
- We are going to replaced the cold war Soviet body armor with:
  - Soft body armor.
  - Modern ceramic body armor.
- We will also standardize a witness pack for fragments. It will be based on the GBR BAE.





New proposed standardizations

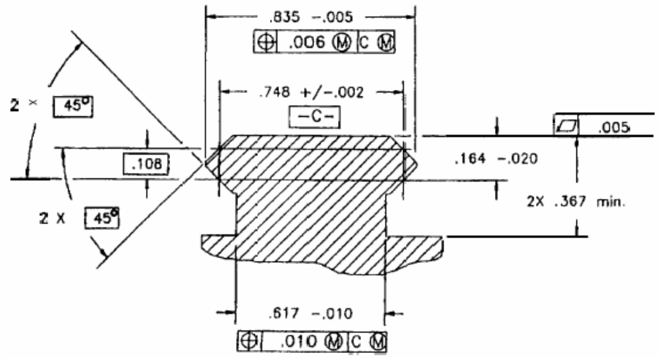
- Up until now all NATO small arms standardization has been ammunition.
- We will now recommend standardization of:
  - NATO Rail
  - NATO Magazines
  - NATO Muzzle Thread
  - NATO Flash Hider Diameter
  - NATO Bayonet Attachment
  - NATO Accessory Attachment



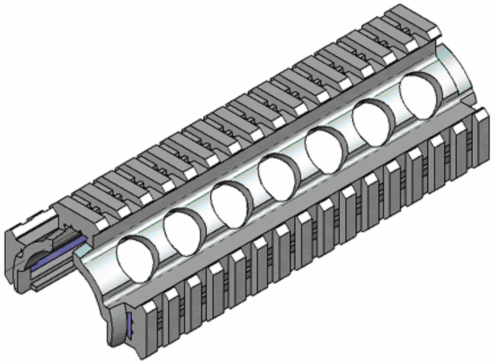
Participating industries:
- Aimpoint
- Beretta
- Colt
- Fabrique National
- Heckler & Koch

Weapon rail history

Desert Storm 1991:
Clamping and duct tape…

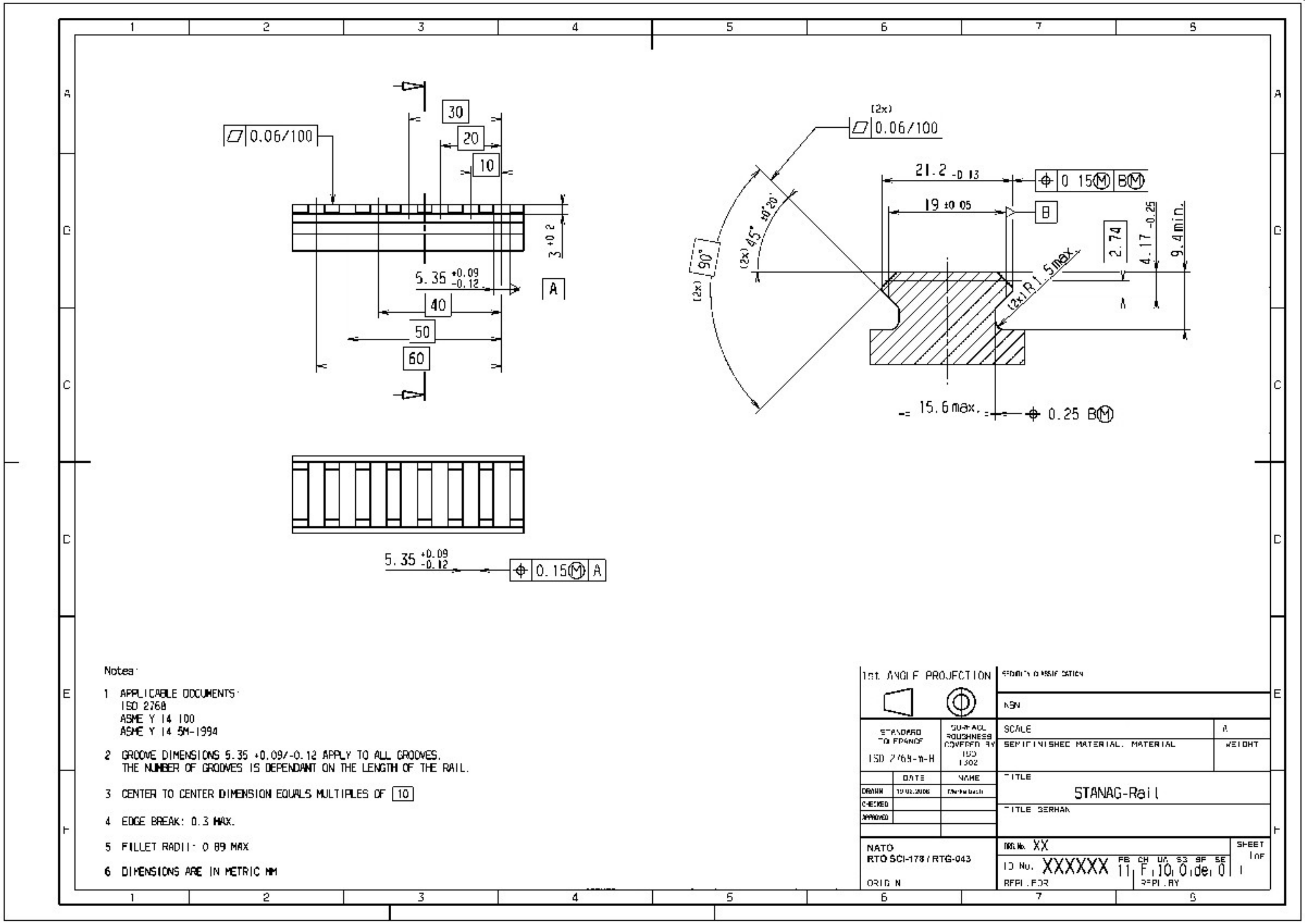


1995 US MIL-STD-1913



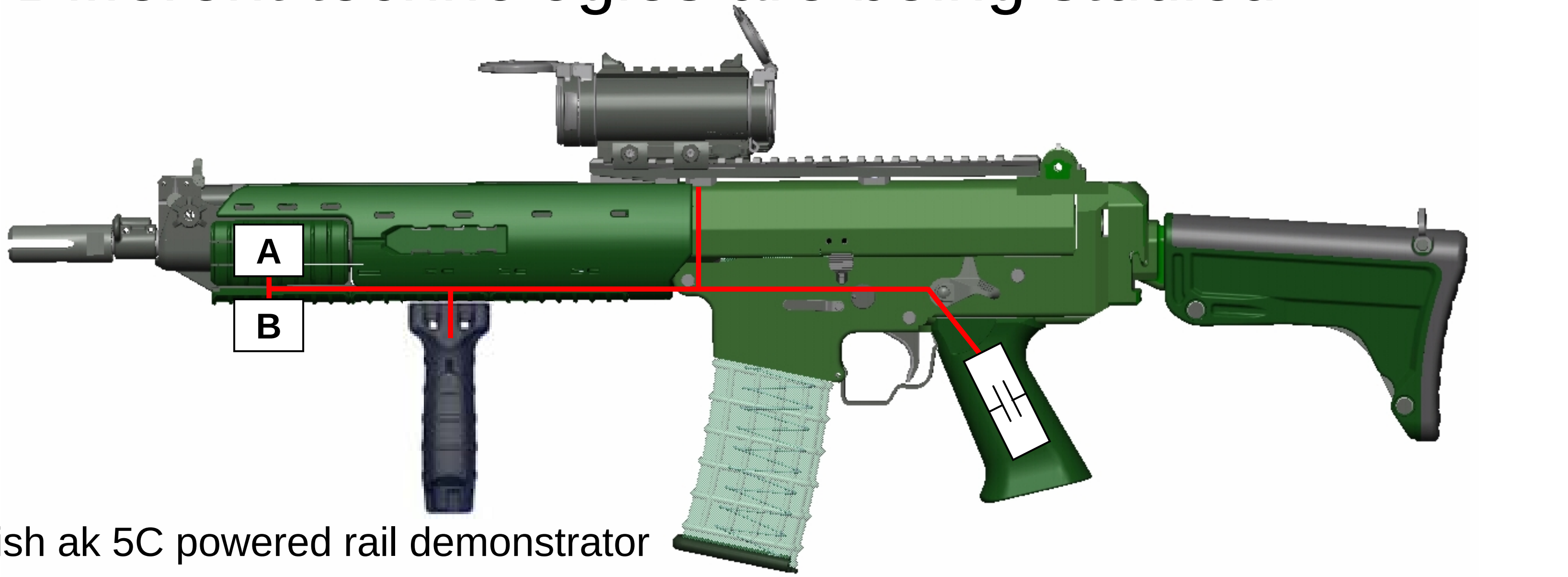
2010 Powered NATO Rail

Proposed NATO rail



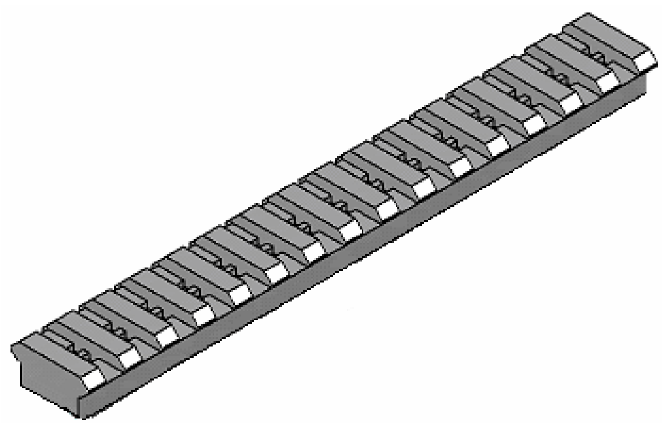
The next step is the NATO powered rail

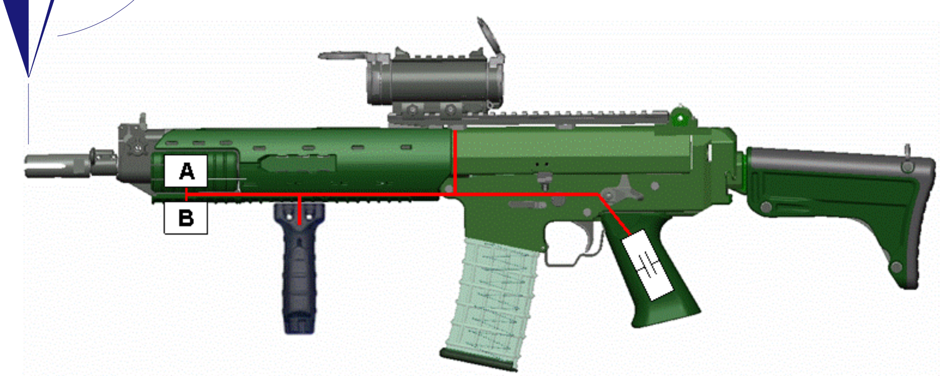
- Centralized power is the key for the future!
- CAN, DEU, SWE and USA have all placed contracts with companies to develop powered rail demonstrators.
- Different technologies are being studied.



Swedish ak 5C powered rail demonstrator

Questions?





Product Manager Crew Served Weapons Overview

For the

Small Arms Symposium & Exhibition

National Defense Industrial Association

19-22 May 2008

BG R. Mark Brown
Program Executive Officer Soldier

LTC Michael Ascura
PM Crew Served Weapons

M240E6, Medium Machine Gun Weight Reduction Program

Background

- M240B Selected In 1996
  - Superior Reliability Performance Compared To The M60
  - Weight Of 27.5 lbs
  - MANPRINT And Human Factors Engr Assessments Identified Weight As A Corrective Action
- IMMG ORD -- Approved Oct 1999
  - 24 lb Threshold / 20 lb Objective Weight
  - P3I for Weight Reduction
    - 4 lb (T) / 7 lb (O) Weight Reduction
    - No Decrease In Weapon Reliability
- Post Combat Surveys Continually Note Weight Of The M240B As The Only Point Of Dissatisfaction With Performance

M240E6 Comparison

- **M240E6 Weight Reduction Focused Upon:**
  - **Receiver Assembly (Riveted Titanium / Steel)**
  - **Barrel Assembly (Reduced Contour; Lightweight Gas System, Sight & Handle)**
  - **Trigger Housing (Composite Construction; Swing-Down Trigger Guard)**
- **Weapon Weights: (Measured)**
  - **M240B: 27.4 lb**
  - **M240E6: 22.3 lb**

	Weight Savings
Receiver	3.2 lb
Barrel	1.4 lb
Trigger Frame	0.5 lb

Program Milestones

- Milestone B Approved 22 March 2005
- System development and demonstration contract award in Sep 2005
- Test and evaluation 2007 through Mar 2008
- Type Classification Limited Procurement – 3QFY08
- Type Classification Standard / Materiel Release – 3QFY10
- First Unit Equipped – 3QFY10

M2
Machine Gun
Enhancements

Legacy System: M2 Brief History

1918 — Air cooled caliber .50 Browning Was first fired

1923 — .50 cal Browning adopted for use on Aircraft and named M1921

1931 — Cavalry Board established performance requirements

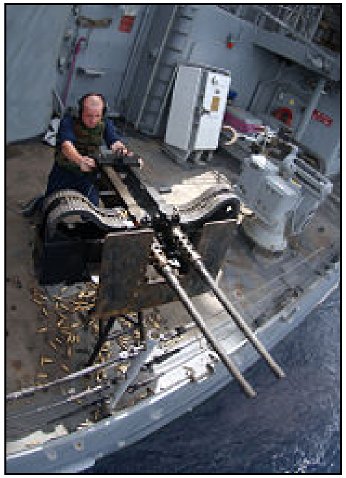
1933 — .50 Cal Browning (M1921) Renamed The M2; Modified To Increase Barrel Mass And Replaced Buffer

1958 — Type Classified Standard A

2007 — Army Contract For 2,587 Guns

2007 — Army Releases Solicitation For QCB Kit

2008 — Army Competitive Contract FY08-FY12



Legacy System: M2 Machine Gun

- The M2 MG Is An Automatic, Recoil-operated, Link-Belt-Fed, Air-Cooled Weapon That Has Been Standard Issue Since 1923
  - Weapon Remained Relatively Unchanged Since 1933

- Current M2 Has Several Limitations:
  - Requires Soldiers To Manually Set Headspace And Timing Every Time A Barrel Is Inserted
  - Improper Adjustment Can Damage The Weapon And Injure The User
  - Barrel Changing Procedures Negatively Impact Survivability
  - Soldiers Are Exposed To Enemy Fire For Extended Time Periods

- Increase In M2 Incidences Resulting In Soldiers Improperly Setting Headspace And Timing On The Weapon
  - 45 H&T Malfunctions Out Of 77 Between 2007-May 2008

Near Term Solution: M2E2

- An Enhancement To The .50 Cal M2 To Include A Fixed Headspace And Timing Configuration And Be As Reliable (If Not Better) Than Current M2
- Upgrades Can Be Fitted On Existing M2 Weapons During M2 Overhaul SARET Fieldings, Etc.
- New Production Weapons To Include Proven Design
- The M2A1 (The Type Classified M2 w/QCB) May Include (Not Limited To) Several Enhancements:
  - Modified Barrel
  - Barrel Extension
  - Barrel Support
  - Barrel Carrying Handle
  - Flash Suppressor
  - Fixed Headspace And Timing Configuration

M2E2 Program Status

- Requirement Is Currently Being Competed
- Bid Sample Hardware Is Undergoing Testing At Aberdeen Proving Grounds, MD
- Government Will Down Select To One Vendor- July 2008
- Government Will Award RDT&E Contract For Kits (35) For Production Qualification Testing And User Assessments
- Type Classification–standard/FRP Decision – August 09

Path Forward:

- Production Kits To Be Introduced Thru Overhaul
- Kits To Be Cut Into New Weapon Production
- New Configuration (M2A1) To Be Fielded To Brigade Sets

M2E2 Program Milestones

Approved Capabilities Production Document	December 2006
Release Request for Proposal	October 2007
Receive Bid Samples	November 2007
Perform Bid Sample Testing	November – June 2008
Down Select	July 2008
Contract Award for DT/LUE hardware	October 2008
Production Verification Test	December–May 2009
Safety Release	November 2008
Limited User Evaluation	January 2009
Test Reports/ SER	June-July 2009
MS C / Type Classification	August 2009
Production Contract Award	October 2009
FUE	July 2010

Additional M2 Enhancements

Current Enhancements:

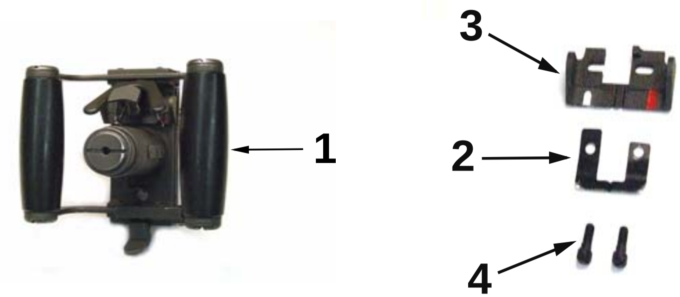
1. Incorporating A Trigger Block To The Back Plate Assembly To Prevent Inadvertent Firings

    1= Backplate

    2= Flatspring

    3= Trigger Block

    4= Shoulder Screw



2. Trigger And Bolt Latch Release Will Be Replaced On Back Plates With Interference

3. Engineering Change Proposal (ECP) Approved For FY07 M2 Gun Production

3. All Future Production To Contain Trigger Blocks

Additional M2 Enhancements (cont.)

Near Term Enhancements:

- Thermal Weapon Sight Brackets (TWS With Side Rails) Provided To PM Sensors And Lasers For Fielding
- Investigating Material Change Of Headspace And Timing Gages To Lower Cost, Increase Corrosion Resistance And Dimensional Stability
- Change M2 Rear Sight Markings From Yards To Meters

Additional Near Term Solution: Lightweight/Low Recoil 50 Cal Machine Gun

Description:

- Lightweight, Low Recoil, 2-man Portable, Vehicle And Ground Mounted .50 Caliber Crew Served Weapon System

Capabilities:

- Provides The Warfighter The Ability To Bring Heavy Machine Gun Lethality In A Medium Machine Gun Form/Weight Factor
- Fires All .50 Caliber Service Ammunition With M9 Links
- 50-60% Lower Weight And 60-75% Lower Recoil Than M2
- Fixed Headspace And Timing
- Quick Change Barrel <15 sec

Program Status:

- Contract Awarded To General Dynamics Armament And Technical Products To Complete Objective Weapon Design And Build 3 Weapons.
- Early User Assessment For SOCOM Completed 9 May. Two Prototype Weapons Fired 10,000 Rounds Over Three Days

CROWS

CROWS Background

- Capability Production Document Approved August 2005

- Currently 243 CROWS In Operation
  - M1114
  - M93 FOX
  - M1A2 TUSK

- Competitive Contract Awarded August 2007
  - Five Year ID/IQ Contract For Up To 6,500 Systems
  - Includes Interim Contractor Logistics Support (ICLS) And Depot Capability

CROWS System Description

- Weight: W/O Weapon And Ammo
  - Above The Roof: 320 Lbs (w/o Armor Kit)
- Total System Weight: 430 Lbs
- Rate Of Production: 120/month (capable of 300/month In early 09) if required
- Supported Weapons:
  - MK19 (96 rds), - M2 (400 rds),
  - M240 (1000 rds), - M249 (2000 rds)
- Platforms: M114/M1151, M93 FOX, RG-31, RG-33, Buffalo, JERRV, M1A2 TUSK,FCS, JLTV, Stryker

Capabilities:
- Four-axis targeting system
- Three-axis vector stabilization
- Day camera: 27X w/47 degree FOV
- Thermal dual FOV (3 & 11 degrees) w/ 2X E-zoom
- Auto focus (day and thermal)
- Auto tracker/auto lead/auto scan
- Laser range finder
- User programmable inhibits

Control Grip (CG)

Fire Control Unit (FCU)

CROWS - Lightning

System Description:

A Lightweight Stabilized Remote Weapon Station (RWS) Which Provides Day And Night Operations. Includes A Laser Range Finder And Ballistic Fire Control System For Accurate Engagements. System Is Capable Of Mounting The M240B Or M249 Machine Gun.

Objective:

Procure Four Systems In Support Of An Operational Assessment To Evaluate The Effectiveness Of A Lightweight RWS For Future Use On Various Combat And Support Vehicles.

Future:

Requirement For A Lightweight RWS Is TBD Pending Evaluation, Analysis And Approval.

M110 Semi-Automatic Sniper System (SASS) Overview

Description:
- Addresses M24 Sniper System & M144 Spotting Scope Shortcomings
- Rapid Fire/Rapid Reload, Suppressed Sniper Rifle
- Effective Against Personnel and Light Materiel Targets Out To 800m
- Supplements Sniper's Role To Support Combat Operations
- Greater Firepower, Configurability/Versatility, Improves Sniper Survivability

Capabilities:
- Greater, Quicker, Focused Firepower with Increased Flexibility
- Ability to "stay on the scope/stay on the gun" for target rich (urban) environments and against moving/fleeting targets
- Additional Responsiveness and Versatility
- Easily Adaptable RSTA Systems For All-Weather, Day/Night Operation
- Increases Sniper Team Lethality, Survivability and Mission Flexibility

Program History:
- HQDA Approved Requirements: 23 Jun 04
- Contract Award: 26 Sep 05
- First Unit Equipped: 14 Nov 07

Basis of Issue: 1:1 replacement for every Sniper Team M24 SWS

Contractor: Knight's Armaments Company, Titusville, FL

Upcoming Competitive Opportunities

- XM205 Lightweight Tripod for Heavy Machine Guns
  - Modified COTS/NDI approach
  - Performance based competition
  - 100% small business set aside
  - Anticipate 1Q09 award

- M2 .50 Caliber Machine Gun
  - Compete the Gov't owned M2 Technical Data Package
  - Anticipate multiple contract awards
  - 20% small business set aside
  - Anticipate 4Q08 award

- MK93 Mod 2 Dual Mount
  - Compete the Gov't owned MK93 Technical Data Package
  - Anticipate multiple contract awards
  - 100% small business set aside
  - Anticipate 1Q09 award

Monitor procnet at http://procnet.pica.army.mil

Project Manager Soldier Weapons Overview

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19-22 May 2008

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Program Executive Officer Soldier

Mr. Richard Audette
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Program Executive Office Soldier

As of 19 Feb 2008

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  - (SEQ) – David Nelson (703) 602-7601
  - (SW) - Shelby Stevens (703) 602-7610
  - (SW) – Fred Callies (703) 602-3147

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- PM Crew Served Weapons

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- PM Air Warrior
- PM Land Warrior

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- PM Clothing & Equipment
- PM Sensor & Lasers
- PM Soldier Survivability

Director Rapid Fielding Initiative
COL Conley
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DD Rapid Fielding Initiative
Sam Parrish
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- Operations
- Logistics
- Fielding
  - CONUS
  - Iraq
  - Afghanistan

Soldier Weapons Mission

PM Soldier Weapons Programs List

DEVELOPMENT

WEAPONS
1. XM25, Individual High Explosive Air Burst Weapon System Technology Demonstration
2. XM101, Common Remotely Operated Weapon Station (CROWS)

SOLDIER ENHANCEMENT PROGRAMS
3. M26, 12 Gauge Modular Accessory Shotgun System (MASS)
4. M68 Close Combat Optics Re-competition
5. XM1116, 12 Gauge Extended Range Non-Lethal Cartridge
6. XM1022, Sniper Ammunition For M107
7. M110, 7.62 Semi-Automatic Sniper System (SASS)
8. Close Quarters Battle (CQB) Kit
9. XM1041/XM1042/XM1071 - Close Combat Mission Capability Kit (M4/M16/M249/M9/M11)
10. Advanced Sniper Accessory Kit (ASAK)
11. XM320, Grenade Launcher Module (GLM)
12. M2 A12 Quick Change Barrel Kit Program

BLOCK MOD PROGRAMS
13. CROWS-Lightning Remote Weapons Station
14. XM150, Rifle Combat Optic (RCO)
15. M2E2 Machine Gun Lightweight Tripod Program
16. Swing Arm Mount For HMMWVs
17. HMMWV Improved Auxiliary Weapon Mount
18. XM240E6, Medium Machine Gun Weight Reduction Program
19. M249 SAW 200 Round Soft Pack

AMMO BLOCK MOD PROGRAMS
20. XM1037, Short Range Training Round For M4, M16 and M249
21. Lightweight Small Caliber Ammunition
22. Proximity Fuzed Door Breaching Cartridge
23. 40mm Day Night Training Cartridge (FCT)

RFI FY08 ITEMS

- TA31 - 4X ACOG (RCO)
- M24 Small Binoculars
- Laser Rangefinder (from XM320)
- M249/M240B Spare Barrel Bag
- Three Point Sling
- Improved Spotting Scope With Tripod
- Improved Cleaning Kit
- Improved Buttstock For M4 Carbine
- Forward Grip Bipod
- M203 Day/Night Sight
- Back Up Iron Sight
- Multiple Magazine Holder
- Forward Rail Bracket (Mini Rail)
- M249 Ammo Soft Pack (100 and 200 rds)
- M240B Combat Ammo Pack (50 rds)
- M192 Lightweight Tripod
- M249 Short Barrel
- M249 Collapsible Buttstock
- Improved M4/M16 Magazine
- Improved M249 Collapsible Buttstock
- M68 Close Combat Optic

PROCUREMENT

24. M151E1 & M151E2 Protector Remote Weapon System (RWS)
25. MK19, Grenade Machine Gun
26. MK19 MODS
27. Mod Kit
28. Lightweight Adjustable Sight Bracket
29. Tactical Engagement Simulator (TES)
30. M107 Semi Automatic Long Range Sniper Rifle
31. M240B/H/E6, 7.62mm Medium MG
32. M240B MODS
33. M192, Light Weight Ground Mount For MG
34. Improved Bipod
35. M240B Collapsible Buttstock
36. Improved Flash Suppressor
37. Combat Ammunition Pack
38. M240B Short Barrel
39. M240B Improved Buttstock
40. Sling Assembly For The M240B
41. M249, 5.56mm Squad Automatic Weapon
42. M249 MODS
43. M192, Lightweight Ground Mount For MG
44. MG Front Rails
45. Improved Bipod
46. M249 Improved Collapsible Buttstock
47. Short Barrel For The M249
48. Sling Assembly For M249
49. M16A4 5.56mm Rifle
50. M16 Rifle Mods
51. M68 Close Combat Optics (CCO)
52. Close Quarters Battle (CQB) Kit (Production)
53. M4, 5.56mm Carbine
54. M4 Mods
55. M145 Machine Gun Optics
56. M25 Stabilized Binoculars
57. M24 Mini Binocular

AMMO PRODUCTION PROGRAMS*

58. M903/M962 Cal .50 SLAP/SLAPT
59. M1001, 40mm Canister Round
60. M100, Grenade Rifle Entry Munition (GREM)
61. M862 5.56mm Short Range Training Ammunition
62. M1030 12 Gauge Breaching Round
63. M973/M974, 7.62 Short Range Training Ammo
64. M992 IR Illumination Cartridge
65. M281 40mm Target Practice Cartridge

* Programs Managed By PM Soldier Weapons For PEO Ammunition In Accordance With MOA

Soldier Weapons Fieldings
(1 August 2002 – 31 March 2008)

79,515 Soldiers In 12 BCTs And 19 EABs FY2008

1,082,659 Soldiers In 112 BCTs & 201 EABs Total

Weapon/Item	FY07	FY08 to date	Total Issued 8/02-12/07
M4 Carbine	72147	17030	183282
M16 Series Rifle	7383	2369	65774
M500 Shotgun	2822	789	15866
M107 Sniper Weapon System	165	84	2210
M249 Machine Gun	3651	2716	23204
M240B Machine Gun	5446	2049	21922
M240H Aviation Machine Gun	728	111	3925
Mk19 Grenade Machine Gun	895	639	4419
M2 Machine Gun	3894	1710	17202
M9 Pistol	8698	5266	33518
M203 Series Grenade Launcher	6014	1930	13868
M14 Rifle	509	50	5406
M79 Grenade Laundcher	0	0	77
CROWS	185	?	261
Backup Iron Sight	58860	26055	251881
M68 CCO	55418	815	301476
M68 CCO Comp M4	37701	31066	68779
M9 Magazine	0	0	131933
M4/M16 Magazine	0	0	1703544
3 Point Sling	145448	15413	322043
ACOGS (All variants)	14326	0	14326

Weapon/Item	FY07	FY08 to date	Total Issued 8/02-12/07
M203 Day/Night sight	10961	5461	27503
Modular Weapon System Kit (M4 ARS)	18168	963	32922
Modular Weapon System Kit (M5 ARS)	3768	49	15016
M4 Forward Grip Bipod	11354	54420	73588
M4 Improved Buttstock	2525	1437	10167
M4/M16 Improved Cleaning Kit	12510	53065	65575
Multipurpose Tool	0	0	166597
M192 Lightweight Ground Mount	5340	1327	11116
Improved Spotting Scope	168	80	1488
M24 Small Binoculars	20366	11075	89264
M145 Machine Gun Optic	3511	797	31371
M249 Rail	7326	213	32262
M249 Short Barrel	16078	1734	42686
M249/M240B Spare Barrel Bag	14760	4366	41009
M249 Collapsible Buttstock	10968	4004	23329
M249 Soft Ammo Pack (100 Round)	14894	6614	66959
M249 Soft Ammo Pack (200 Round)	9515	900	25605
M240B Rail	0	0	3281
M240B Combat Ammo Pack	7207	763	18622
Forward Rail Bracket (Mini Rail)	1921	15868	17789
Multiple Magazine Holder	11660	37778	49438


PROJECT MANAGER
SOLDIER
WEAPONS
THE BEST
FOR THE BEST

USAF
Combat Weapons Program

Colonel Charles Beck
HQ AFSFC/SFX
DSN 945-0101
COMM 210-925-0101

USAF Modular Handgun System

- **Vision**
  - **Procure a new handgun for USAF that meets all combat requirements and provides increased capabilities**
    - **Focus on AF operational needs with joint partnerships**
    - **Ensure combat needs of all AF users addressed**
    - **Capitalize on emerging technology**
    - **Close capability gaps with current handguns**
- **Goals**
  - **Provide Airmen with a more effective handgun**
    - **Increased permanent wound channel volume, given minimum penetration**
    - **Use readily available military cartridge**
  - **Use commercial/non-developmental solution**
  - **Take advantage of industry’s new handgun technologies**

USAF Modular Handgun System

- **Desired Capabilities and New Technologies**
  - **Optimum incapacitation potential on the battlefield based on increased wounding effect with larger non-expanding fully jacketed bullets**
  - **Enhanced corrosion control; reduced operator maintenance**
  - **More shooter friendly, ergonomic design for average to small hands; reduced felt recoil, enhancing shooter accuracy**
  - **Size options (standard, compact, etc.) to accommodate certain missions (aircrew, OSI, Personal Security Officer) in same model**
  - **Modular grip panels/inserts (operator ability to adjust grip size)**
  - **External safety controls on receiver**
  - **Ambidextrous controls (safety, magazine release, slide stop)**

USAF Modular Handgun System

- **Quantities needed and acquisition timeline**
  - **AF requirement is ~ 100,600 pistols and associated ammo**
  - **Key milestones/decision points:**
    - **AF Requirements for Operational Capabilities Council – Approved**
    - **AF Capabilities Production Document (CPD) – Approved**
    - **Joint CPD – Approved**
    - **Joint Requirements Oversight Council – Approved for Joint Interest**
    - **Sources Sought Announcement to industry – Posted on FedBiz Ops**
    - **Acquisition strategy – being worked by Army to support AF**
    - **Release Request for Proposal (RFP) for test articles with options for production – Pending**
    - **Execute initial down-select from RFP submissions – Pending**
    - **Complete test, final down-select and award contract – Pending**

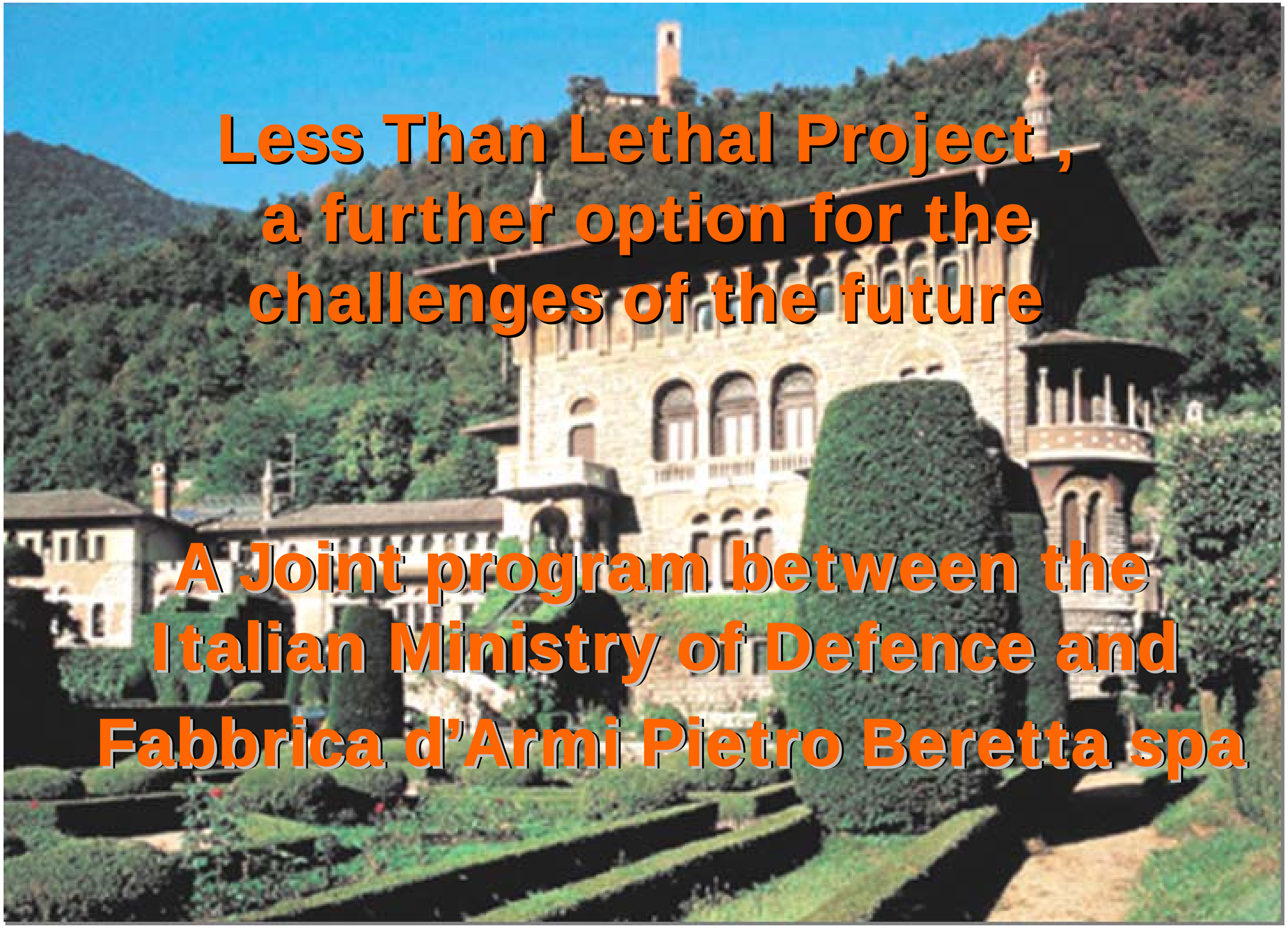
Summary

- **AF procuring 100,600 COTS/NDI handguns**
- **Army, Executive Agent/Air Force, capabilities sponsor**
  - **Army will lead acquisition management (contracting, engineering, business management, testing, supportability planning, program management and milestone decision auth**
  - **AF responsible for funding, source selection authority, evaluation board members, capabilities document management, training package development and logistics integration for AF unique needs**
- **Provide Airmen a handgun with increased permanent wound channel volume and capitalize on industry's new handgun technologies**

LESS·THAN·LETHAL·CONCEPT

BERETTA

Approved for Public Release



Less Than Lethal Project , a further option for the challenges of the future

A Joint program between the Italian Ministry of Defence and Fabbrica d’Armi Pietro Beretta spa

BERETTA

- Beretta in the “ Less than Lethal program “
- Our targets
- Technological Demonstrator
- Human Engineering e Integration

Beretta in the Program “Less Than Lethal “

BERETTA

- The Italian Ministry of Defence launched in 2001 a R&D program called “ **Less Than Lethal** “ to complete its effort of enhancing the combat capability in peace keeping and international police operations within the innovative program “ ***Soldier of the Future*** “ .
- December 2002. A contract was signed between Beretta and Italian M.O.D. for the development of a technological demonstrator of a Less Than Lethal weapon system.
- April 2006 : The first three technological demonstrators have been successfully tested and accepted by the Italian Army .
- 2007 : user trials to be carried out for doctrine assessment of use of LTL weapon system .
- 2008: Limited fielding of the system within the IMOD

Technological Demonstrator

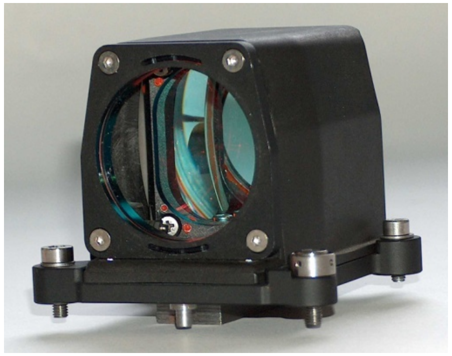
BERETTA

- A more ergonomic design study which includes a collapsable/ foldable stock is foreseen for the production runs

The sub systems

BERETTA

launcher



Sigth / Range finder

Ammunition

Our targets

To develop a technological concept which will include a launcher , a dedicated ammunition and optical sight for a less than lethal weapon system to demonstrate the possibility to deliver the same kinetic energy within a range from **15 meters** (49.3 ft) up to **70 meters (**230 ft **)** :

- Ergonomics (similar to a traditional shotgun)
- Blunt trauma analysis (for effective less than lethal capability)
- **Constant Kinetic Energy principle using traditional propellant ammunition**
- Basic and cost effective range estimation system.

External ballistics

Accuracy :

39.3”

230ft

Target **H+L= 1000 mm (at 70 meters)**

500 mm

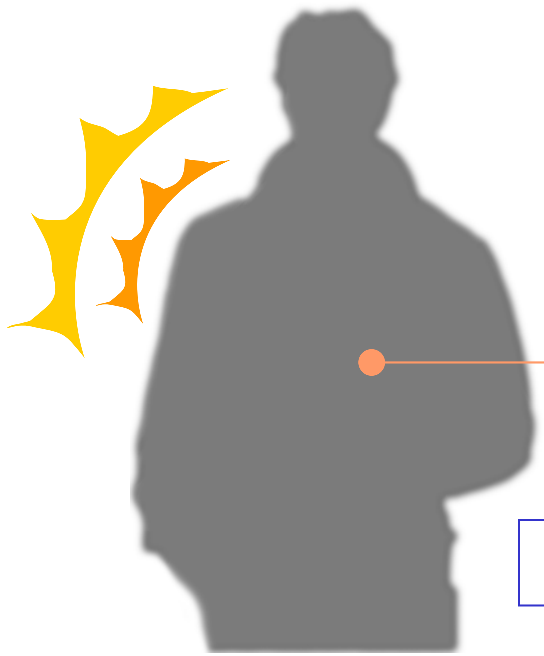
500 mm

230 ft

49.3 ft

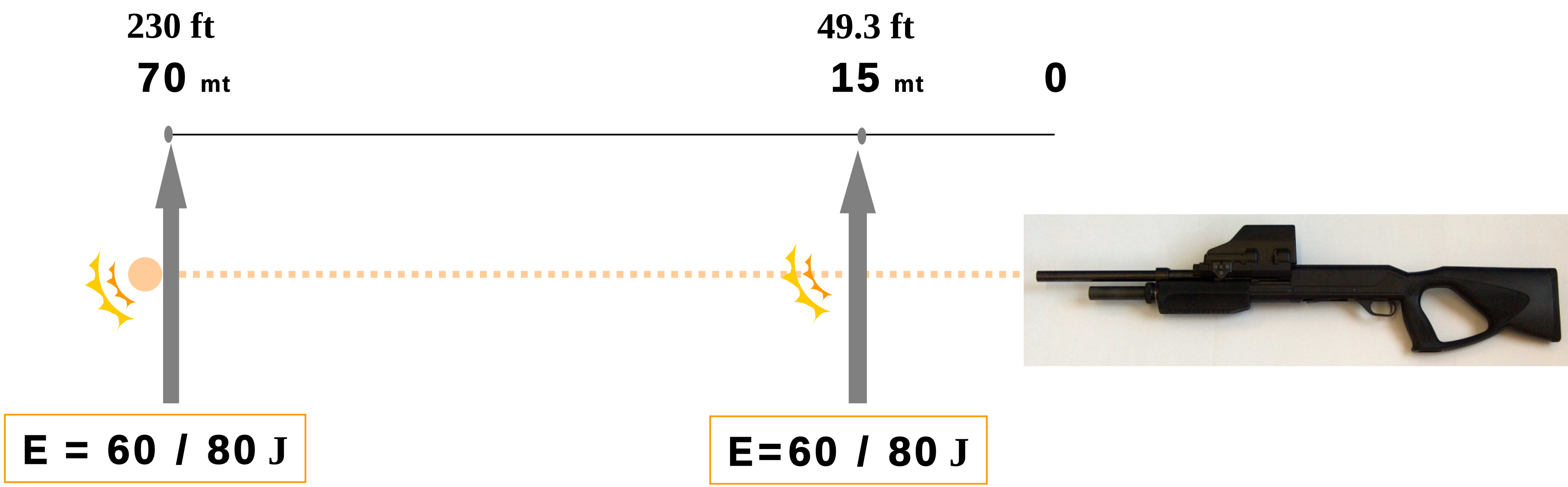
70 mt **15 mt** **0**

Terminal ballistics, blunt trauma analysis



Max E less than 60 ÷ 80 J

Constant Kinetic Energy principle



Confidential

HDSSP projectile

High Deformation Spin Stabilized Projectile

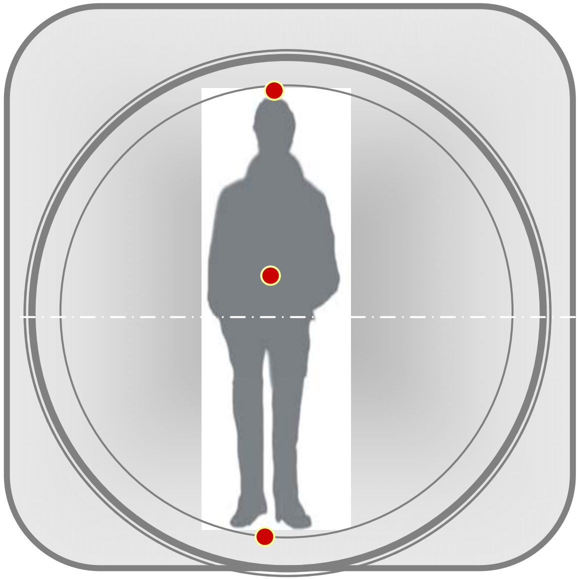
Range estimation

49.3 ft

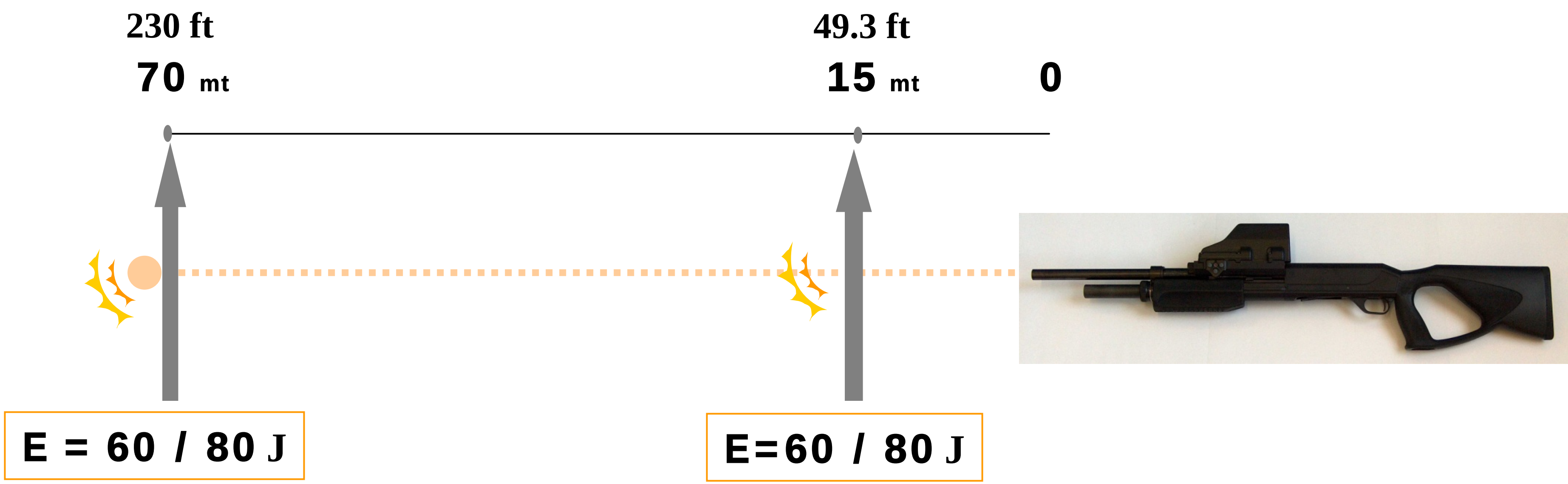
15 meters

70 meters

230 ft

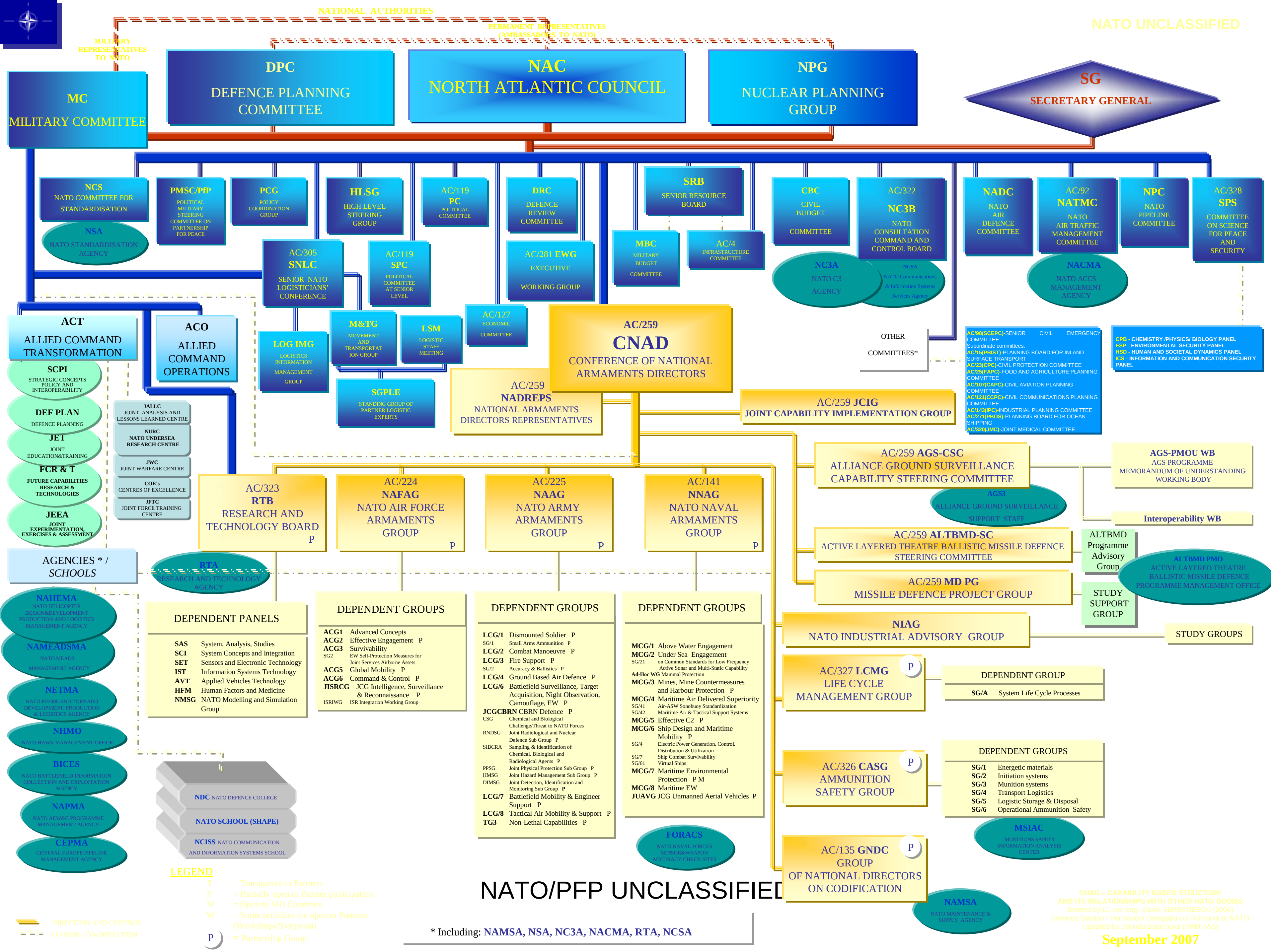


Constant Kinetic Energy principle

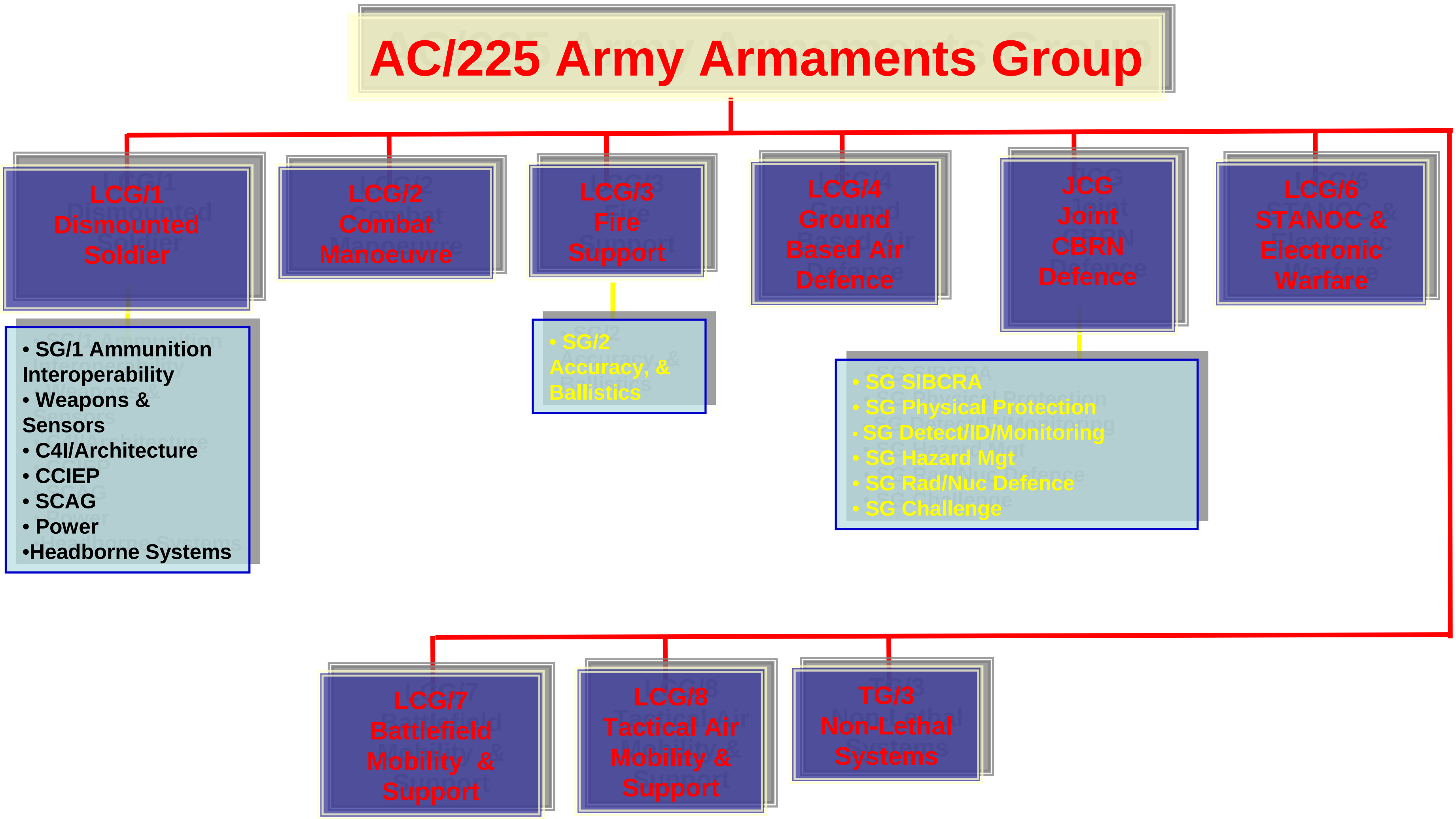


NORTH ATLANTIC TREATY ORGANIZATION
ORGANISATION DU TRAITE DE L' ATLANTIC NORD
AC/225 Land Capability Group 1
Dismounted Soldier

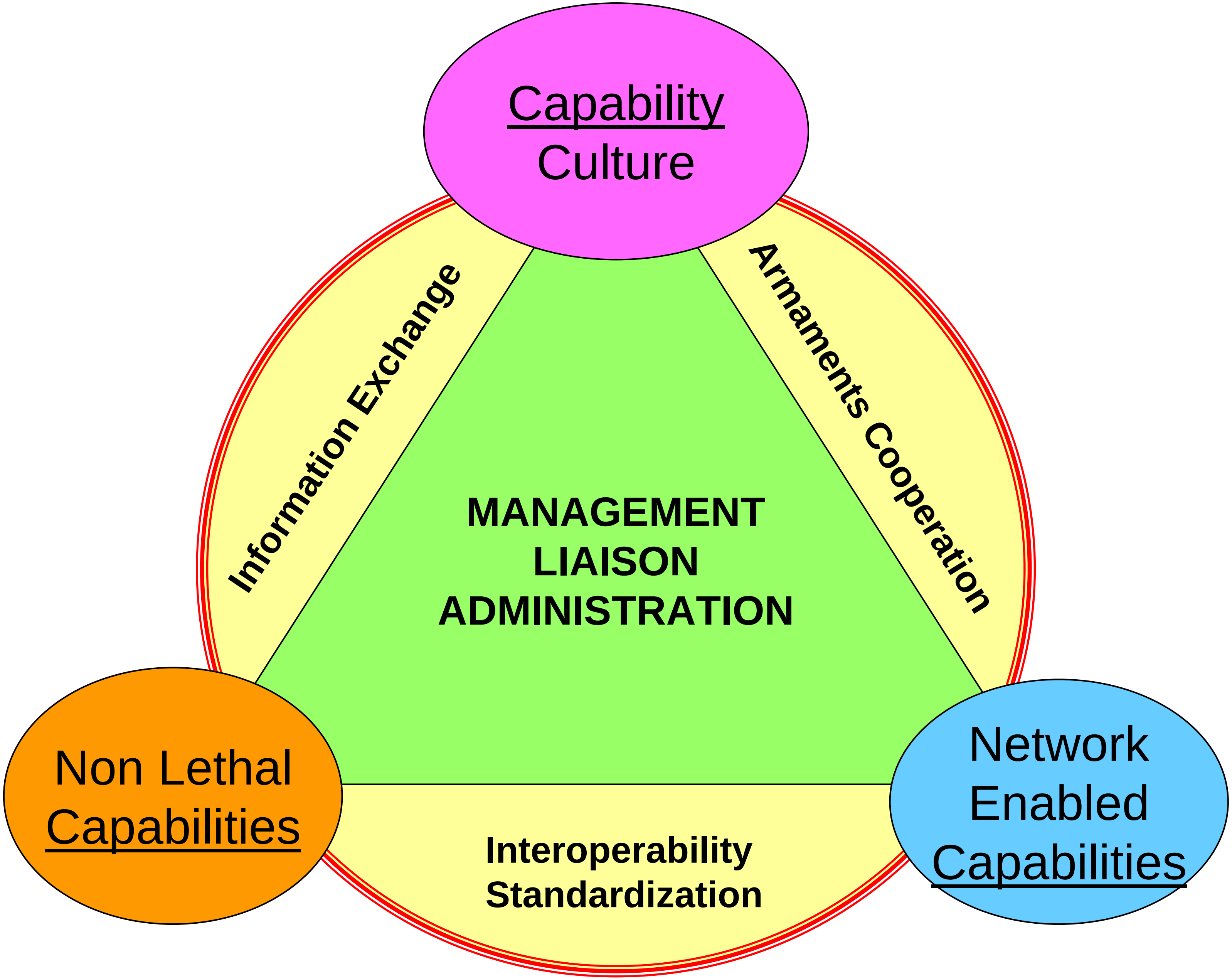
LCol Mike Bodner, CANADA
Chairman


NATO UNCLASSIFIED
NATIONAL AUTHORITIES
PERMANENT REPRESENTATIVES (AMBASSADORS TO NATO)
MILITARY REPRESENTATIVES TO NATO
MC MILITARY COMMITTEE
DPC DEFENCE PLANNING COMMITTEE
NAC NORTH ATLANTIC COUNCIL
NPG NUCLEAR PLANNING GROUP
SG SECRETARY GENERAL
NCS NATO COMMITTEE FOR STANDARDISATION
NSA NATO STANDARDISATION AGENCY
PMSC/PfP POLITICAL MILITARY STEERING COMMITTEE ON PARTNERSHIP FOR PEACE
PCG POLICY COORDINATION GROUP
HLSG HIGH LEVEL STEERING GROUP
AC/119 PC POLITICAL COMMITTEE
DRC DEFENCE REVIEW COMMITTEE
SRB SENIOR RESOURCE BOARD
CBC CIVIL BUDGET COMMITTEE
AC/322 NC3B NATO CONSULTATION COMMAND AND CONTROL BOARD
NADC NATO AIR DEFENCE COMMITTEE
AC/92 NATMC NATO AIR TRAFFIC MANAGEMENT COMMITTEE
NPC NATO PIPELINE COMMITTEE
AC/328 SPS COMMITTEE ON SCIENCE FOR PEACE AND SECURITY
AC/305 SNLC SENIOR NATO LOGISTICIANS' CONFERENCE
AC/119 SPC POLITICAL COMMITTEE AT SENIOR LEVEL
AC/281 EWG EXECUTIVE WORKING GROUP
MBC MILITARY BUDGET COMMITTEE
AC/4 INFRASTRUCTURE COMMITTEE
NC3A NATO C3 AGENCY
NCSA NATO Communications & Information Systems Services Agency
NACMA NATO ACCS MANAGEMENT AGENCY
ACT ALLIED COMMAND TRANSFORMATION
ACO ALLIED COMMAND OPERATIONS
LOG IMG LOGISTICS INFORMATION MANAGEMENT GROUP
M&TG MOVEMENT AND TRANSPORTATION GROUP
LSM LOGISTIC STAFF MEETING
AC/127 ECONOMIC COMMITTEE
SGPLE STANDING GROUP OF PARTNER LOGISTIC EXPERTS
AC/259 CNAD CONFERENCE OF NATIONAL ARMAMENTS DIRECTORS
AC/259 NADREPS NATIONAL ARMAMENTS DIRECTORS REPRESENTATIVES
AC/259 JCIG JOINT CAPABILITY IMPLEMENTATION GROUP
OTHER COMMITTEES*
AC/98(SCEPC)-SENIOR CIVIL EMERGENCY COMMITTEE
Subordinate committees:
AC/15(PBIST)-PLANNING BOARD FOR INLAND SURFACE TRANSPORT
AC/23(CPC)-CIVIL PROTECTION COMMITTEE
AC/25(FAPC)-FOOD AND AGRICULTURE PLANNING COMMITTEE
AC/107(CAPC)-CIVIL AVIATION PLANNING COMMITTEE
AC/121(CCPC)-CIVIL COMMUNICATIONS PLANNING COMMITTEE
AC/143(IPC)-INDUSTRIAL PLANNING COMMITTEE
AC/271(PBOS)-PLANNING BOARD FOR OCEAN SHIPPING
AC/320(JMC)-JOINT MEDICAL COMMITTEE
CPB - CHEMISTRY /PHYSICS/ BIOLOGY PANEL
ESP - ENVIRONMENTAL SECURITY PANEL
HSD - HUMAN AND SOCIETAL DYNAMICS PANEL
ICS - INFORMATION AND COMMUNICATION SECURITY PANEL
SCPI STRATEGIC CONCEPTS POLICY AND INTEROPERABILITY
DEF PLAN DEFENCE PLANNING
JET JOINT EDUCATION&TRAINING
FCR & T FUTURE CAPABILITIES RESEARCH & TECHNOLOGIES
JEEA JOINT EXPERIMENTATION, EXERCISES & ASSESSMENT
JALLC JOINT ANALYSIS AND LESSONS LEARNED CENTRE
NURC NATO UNDERSEA RESEARCH CENTRE
JWC JOINT WARFARE CENTRE
COE's CENTRES OF EXCELLENCE
JFTC JOINT FORCE TRAINING CENTRE
AGENCIES * / SCHOOLS
RTA RESEARCH AND TECHNOLOGY AGENCY
NAHEMA NATO HELICOPTER DESIGN&DEVELOPMENT PRODUCTION AND LOGISTICS MANAGEMENT AGENCY
NAMEADSMA NATO MEADS MANAGEMENT AGENCY
NETMA NATO EF2000 AND TORNADO DEVELOPMENT, PRODUCTION & LOGISTICS AGENCY
NHMO NATO HAWK MANAGEMENT OFFICE
BICES NATO BATTLEFIELD INFORMATION COLLECTION AND EXPLOITATION AGENCY
NAPMA NATO AEW&C PROGRAMME MANAGEMENT AGENCY
CEPMA CENTRAL EUROPE PIPELINE MANAGEMENT AGENCY
NDC NATO DEFENCE COLLEGE
NATO SCHOOL (SHAPE)
NCISS NATO COMMUNICATION AND INFORMATION SYSTEMS SCHOOL
AC/323 RTB RESEARCH AND TECHNOLOGY BOARD P
AC/224 NAFAG NATO AIR FORCE ARMAMENTS GROUP P
AC/225 NAAG NATO ARMY ARMAMENTS GROUP P
AC/141 NNAG NATO NAVAL ARMAMENTS GROUP P
DEPENDENT PANELS
SAS System, Analysis, Studies
SCI System Concepts and Integration
SET Sensors and Electronic Technology
IST Information Systems Technology
AVT Applied Vehicles Technology
HFM Human Factors and Medicine
NMSG NATO Modelling and Simulation Group
DEPENDENT GROUPS
ACG1 Advanced Concepts
ACG2 Effective Engagement P
ACG3 Survivability
SG2 EW Self-Protection Measures for Joint Services Airborne Assets
ACG5 Global Mobility P
ACG6 Command & Control P
JISRCG JCG Intelligence, Surveillance & Reconnaissance P
ISRIWG ISR Integration Working Group
DEPENDENT GROUPS
LCG/1 Dismounted Soldier P
SG/1 Small Arms Ammunition P
LCG/2 Combat Manoeuvre P
LCG/3 Fire Support P
SG/2 Accuracy & Ballistics P
LCG/4 Ground Based Air Defence P
LCG/6 Battlefield Surveillance, Target Acquisition, Night Observation, Camouflage, EW P
JCGCBRN CBRN Defence P
CSG Chemical and Biological Challenge/Threat to NATO Forces
RNDSG Joint Radiological and Nuclear Defence Sub Group P
SIBCRA Sampling & Identification of Chemical, Biological and Radiological Agents P
PPSG Joint Physical Protection Sub Group P
HMSG Joint Hazard Management Sub Group P
DIMSG Joint Detection, Identification and Monitoring Sub Group P
LCG/7 Battlefield Mobility & Engineer Support P
LCG/8 Tactical Air Mobility & Support P
TG3 Non-Lethal Capabilities P
DEPENDENT GROUPS
MCG/1 Above Water Engagement
MCG/2 Under Sea Engagement
SG/21 on Common Standards for Low Frequency Active Sonar and Multi-Static Capability
Ad-Hoc WG Mammal Protection
MCG/3 Mines, Mine Countermeasures and Harbour Protection P
MCG/4 Maritime Air Delivered Superiority
SG/41 Air-ASW Sonobuoy Standardization
SG/42 Maritime Air & Tactical Support Systems
MCG/5 Effective C2 P
MCG/6 Ship Design and Maritime Mobility P
SG/4 Electric Power Generation, Control, Distribution & Utilization
SG/7 Ship Combat Survivability
SG/61 Virtual Ships
MCG/7 Maritime Environmental Protection P M
MCG/8 Maritime EW
JUAVG JCG Unmanned Aerial Vehicles P
FORACS NATO NAVAL FORCES SENSOR&WEAPON ACCURACY CHECK SITES
AC/259 AGS-CSC ALLIANCE GROUND SURVEILLANCE CAPABILITY STEERING COMMITTEE
AGS3 ALLIANCE GROUND SURVEILLANCE SUPPORT STAFF
AGS-PMOU WB AGS PROGRAMME MEMORANDUM OF UNDERSTANDING WORKING BODY
Interoperability WB
AC/259 ALTBMD-SC ACTIVE LAYERED THEATRE BALLISTIC MISSILE DEFENCE STEERING COMMITTEE
ALTBMD Programme Advisory Group
ALTBMD PMO ACTIVE LAYERED THEATRE BALLISTIC MISSILE DEFENCE PROGRAMME MANAGEMENT OFFICE
AC/259 MD PG MISSILE DEFENCE PROJECT GROUP
STUDY SUPPORT GROUP
NIAG NATO INDUSTRIAL ADVISORY GROUP
STUDY GROUPS
AC/327 LCMG LIFE CYCLE MANAGEMENT GROUP P
DEPENDENT GROUP
SG/A System Life Cycle Processes
AC/326 CASG AMMUNITION SAFETY GROUP P
DEPENDENT GROUPS
SG/1 Energetic materials
SG/2 Initiation systems
SG/3 Munition systems
SG/4 Transport Logistics
SG/5 Logistic Storage & Disposal
SG/6 Operational Ammunition Safety
MSIAC MUNITIONS SAFETY INFORMATION ANALYSIS CENTER
AC/135 GNDC GROUP OF NATIONAL DIRECTORS ON CODIFICATION P
NAMSA NATO MAINTENANCE & SUPPLY AGENCY
NATO/PFP UNCLASSIFIED
* Including: NAMSA, NSA, NC3A, NACMA, RTA, NCSA
LEGEND
T = Transparent to Partners
P = Partially open to Partner participation
M = Open to MD Countries
W = Some activities are open to Partners (Workshops/Symposia)
DIRECTION AND CONTROL
LIAISON / CO-OPERATION
P = Partnership Group
CNAD – CAPABILITY BASED STRUCTURE AND ITS RELATIONSHIPS WITH OTHER NATO BODIES
September 2007

NATO Army Armaments Group



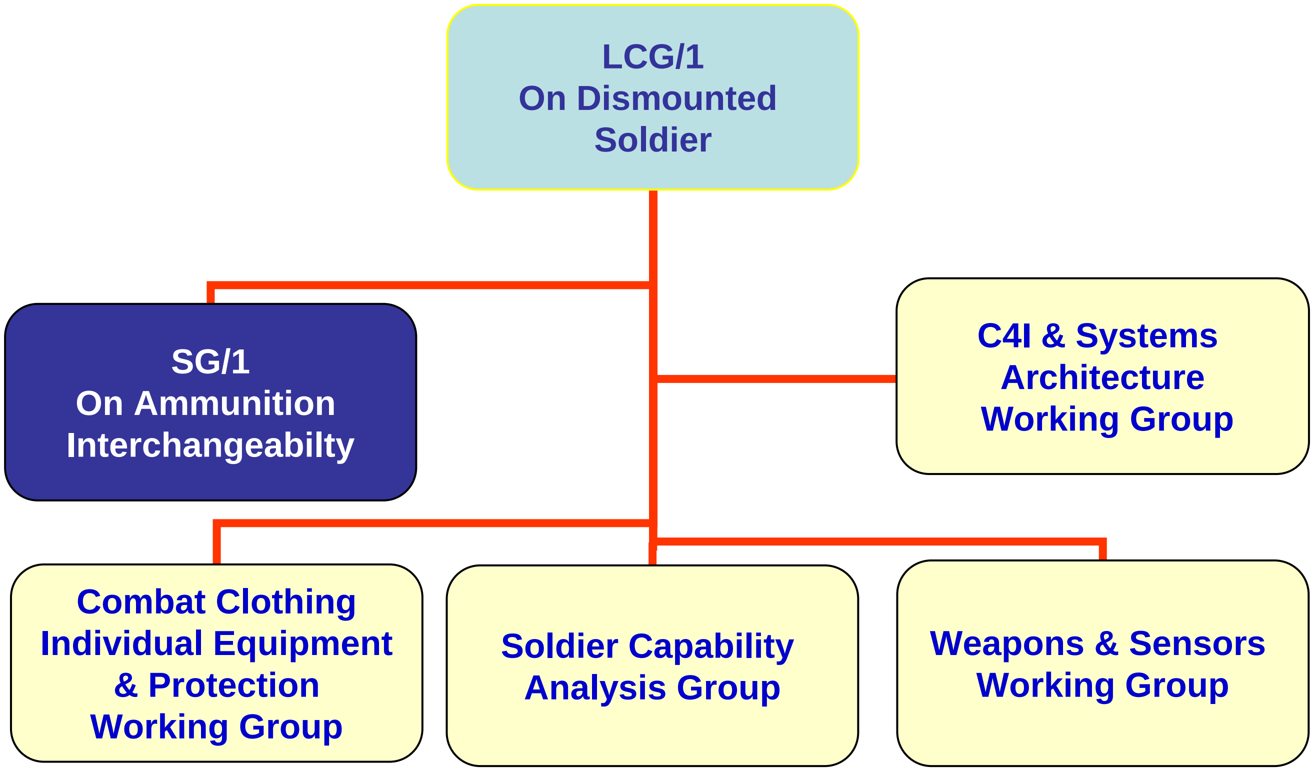
NATO/PFP UNCLASSIFIED


Capability
Culture
Information Exchange
Armaments Cooperation
MANAGEMENT
LIAISON
ADMINISTRATION
Non Lethal
Capabilities
Network
Enabled
Capabilities
Interoperability
Standardization

Mission - Main Armament Groups

- NATO Armament Handbook – 27 Jul 2006
  - Foster exchange of Information
  - Promote technical Standardization
  - Identify and promote Technical advancements
  - Plan/direct/coord subordinate groups
  - Liaise with all relevant organizations
    - Within NATO – RTO, IMS, NIAG, ACT, NSA,etc
    - Outside as Auth – EU, NGOs, Industry, etc

LCG/1 and Sub-groups



Two Team of Experts - Power and Head-borne Systems

NATO Soldier System History

- Working Group of Experts in Panel 3
  - 1991-1993
- NIAG Pre-Feasibility Study Dismounted Soldier Modernization – Scanned onto Web Site
  - 1992-1994
- WG 3 of Panel 3 Soldier Modernization
  - 1994- Oct 2000
- Topical Group 1 Soldier System Interoperability
  - Oct 2000 – Dec 2005
- Land Group 1 Soldier Systems
  - Jan 2006
- Land Capability Group 1 Dismounted Soldier
  - Jan 2007

Land Capability Group 1 Management

- **Chairman**
  - **LCol Mike Bodner – CAN**
- **Deputy Chairman**
  - **LCol Wolfgang Althoff - DEU**
- **NATO International Staff Support**
  - **Matt Dove – Land Armaments Unit, NATO HQ**
- **Land Capability Group 1 - Many Delegations**
  - **NATO Countries - 21**
  - **Partners - 6**
  - **Contact Country – 1 (Australia)**

LCG/1 Sub – Group/Working Group Structure

- **<u>Sub-Group/1 Ammunition Interchangeability</u>**
  - **Col Dirk Hemerlick – BEL Chairman**
  - **Iain Morris – GBR Superintendent ERTC**
  - **Dominic Pellegrino – USA Superintendent NRTC**
- **<u>Soldier Capabilities & Analysis Group</u>**
  - **Mr Mark Richter – USA Chairman**
  - **Maj Torstein Johnson – NOR Deputy**
- **<u>Combat Clothing Individual Equipment & Protection WG</u>**
  - **Mr Henk Reulink – NLD Chairman**
  - **Maj Dan Fitzgerald – USA Deputy**
- **<u>C4I & Systems Architecture WG</u>**
  - **Mr JD Wilson – USA Chairman**
  - **Mr Marcel VanderLee – NLD Deputy**
- **<u>Weapons & Sensors WG</u>**
  - **Per Arvidson – SWE Chairman**
  - **Deputy Chairman – Vacant**
- **<u>Power TOE</u>**
  - **Chairman - Vacant**
  - **Maj Paul Soulliere – CAN Deputy**
- **<u>Headborne Systems TOE</u>**
  - **Chairman -Vacant**

Specific Work of LCG 1

<u>Sub Group 1 Ammunition Interchangeability</u>

Qualify NATO Ammunition designs

- **Certify NATO Interchangeability**
- **Operate NATO Regional Test Centers**
- **Certify National Test Centers**
- **This year**
  - ✓ **Qualified 4 new 5.56mm ammunition designs**
  - ✓ **Qualified 4 new 7.62mm ammunition designs**
  - ✓ **Conducted production tests on 14 approved designs**
  - ✓ **Revised the list of NATO nominated weapons**
  - ✓ **Completed a draft STANAG and MOPI for 30mm**
  - ✓ **Two national test centers certified for selected calibers**

Specific Work of LCG 1

<u>Soldier Capability and Analysis Group</u>

- **Serve as oversight and provide operational direction to LCG/1**
- **Develop Operational Scenarios of Coalition interoperability at the Dismounted individual Level**
- **Provide rationale for work**
- **USA has assumed Chair**
- **Completed 3 Dismounted Coalition Scenarios**

  Approved by ACT Feb 2007
- **Completed an Overarching Definition and Capabilities document**

  Approved March 2007

Specific Work of LCG 1

Combat Clothing Individual Equipment and Protection Working Group

- **Group is addressing LTCR MF/12/6 Integrated Personal Protection (one of the CNAD top 16)**
- **Ballistic Test Methods for Personal Armour Materials**

  Approved March 2007
- **Updating Laser eye Protection**
- **Tracking Smart Textiles**

Specific Work of LCG 1

C4I / Systems Architecture Working Group

- Develop the ability to exchange tactical map information and individual soldier positional information at the soldier level – NAAG Chairman MGen Dam, NLD
- “Electrical Connectivity Standards for Dismounted Soldier Systems”

  Approved March 2007
- “Information exchange data definitions & inter-process communications protocols between dismounted soldier battlefield management systems”

  Currently out for approval
- “Connectivity Standards for soldier battle management systems”

  Currently out for approval

Specific Work of LCG 1

Weapons & Sensors Working Group

- Review STANAGs and Nations SA plans
- RTO Study initiated to address issues associated with:
  - ✓ Weapons interfaces
  - ✓ Human Factors & analysis
  - ✓ Electrical Power
  - Firing trial conducted at a USMC Base
  - Deliver a Technical Report by Dec 2008
  - Effort will form basis for future work

Summary to Industry

- NATO / NAAG has restructured to a capability-based focus to better align with the Allied Command Transformation (ACT).
- LGC/1 is a large group with significant responsibilities
- All dismounted soldier standardization falls under NAAG - most in LCG 1

Advancements in 40mm Ammunition

Low Velocity High Velocity

22 May 2008

Session Overview—Introduction

Dave Broden
Broden Resource Solutions LLC
NDIA
Small Arms Symposium 2008

Objectives

- Establish Rigorous Engineering Based Design and Performance Rationale for 40mm Grenade Ammunition
  - Low Velocity Family
  - High Velocity Family
  - Product Improvements
  - Weapon Interfaces
- Evolve Improved Documentation for:
  - Technical Data Packages
  - Specifications
  - Performance Characteristics
    - Interior, Exterior, Terminal Ballistics
    - Reliability
    - Safety
- Support Performance, On-Going, Production, and Operational Failure Analysis

40mm Ammunition Government Technology Insertion Team

• Melissa Wanner	PM-MAS	Project Management Engineer
• James Grassi	ARDEC	40mm Special Projects Lead
• Adam Sorchini	ARDEC	Project Engineer
• Adam Jacob	ARDEC	Project Engineer
• Jason Wasserman	ARDEC	Project Engineer
• Peter Martin	ARDEC	Project Engineer
• Christopher Summa	ARDEC	Project Engineer
• Matthew Millar	ARDEC	Project Engineer

40mm Ammunition Technology Insertion Participants

- US Army PM—MAS
- USAIC
- US Army JMC
- ARDEC
- PEO Soldier Weapons
- ARL
- ATC
- 40mm Ammunition System Management Contractors
  - AMTEC Corporation
  - DSE
- Various Supporting Subcontractors

Integrated Product Team (IPT)
Linking
Technology, Development, Production
To Realize
40mm Ammunition Improvements

40mm Technology Advancement Highlights

- **Focused on Rigorous Engineering**
  - **Analysis**
  - **Design/Development**
  - **Test**
  - **Producibility**

- **Establishing 40mm Ammunition Baseline Characteristics**
  - **Performance Characteristics**
  - **Identifying and Addressing Concerns**
  - **Supporting On Going Production**

- **Implementing Product Improvement Priorities**
  - **Performance (Ballistic, Reliability, Quality, Safety etc.)**
  - **Producibility**
  - **Affordability**

40mm Technology Advancement Status Presentations

- **Producibility Improvements of 40m High and Low Velocity Shaped Charge Liners**
  - **Mr. Adam Sorchini**
- **Center of Mass Changes During Arming of 40mm Fuzes**
  - **Mr. Adam Jacob**
- **Electronics and Sensors in 40mm Low Velocity Grenade Ammunition**
  - **Mr. Jason Wasserman**

40mm Technology Advancement Status Presentations

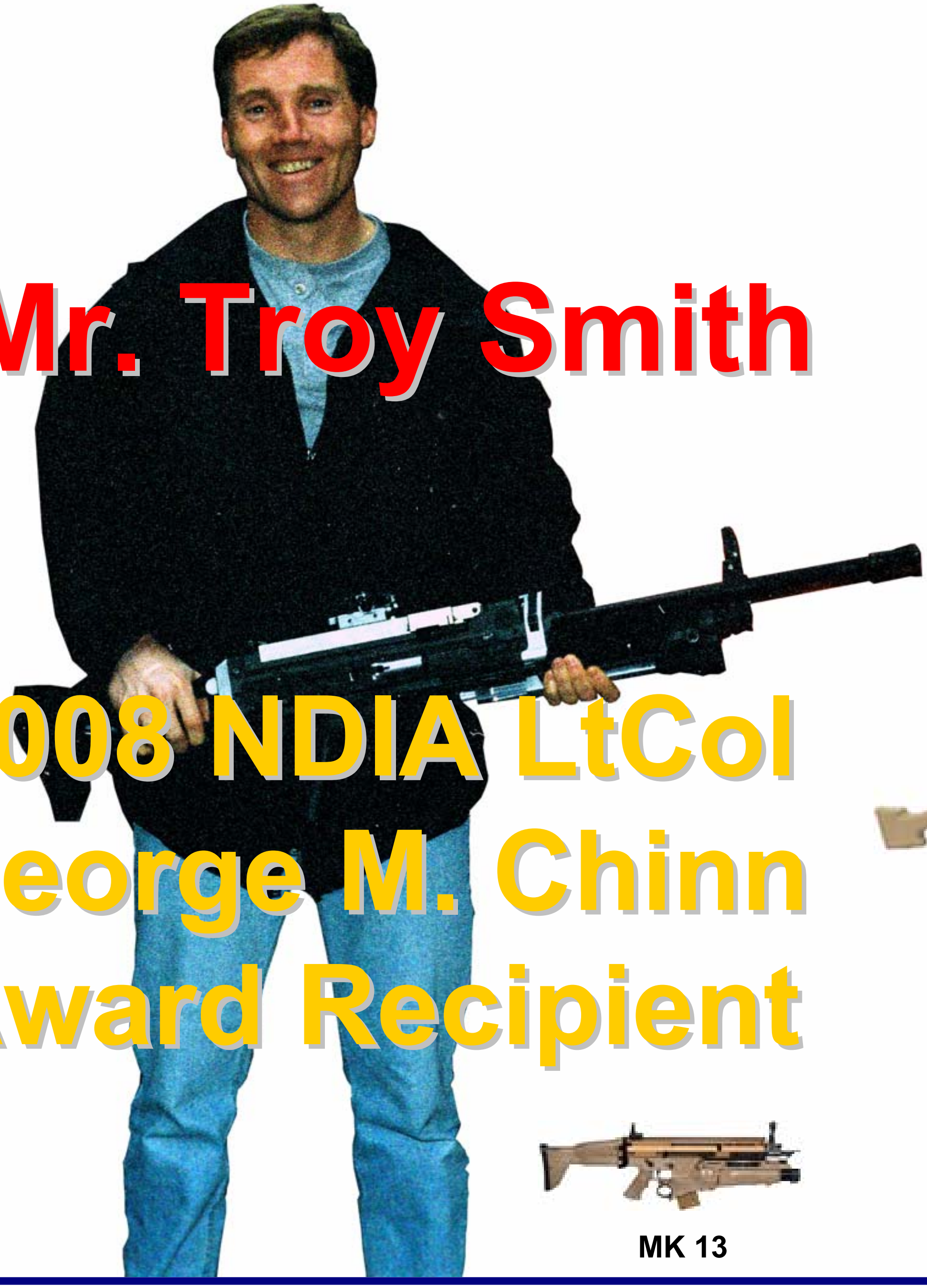
- 40mm Day/Night Practice Cartridge for Mk13/XM320/M203 Grenade Launchers
  - Mr. Peter Martin
- M385A1 Composite Projectile Feasibility Study
  - Mr. Christopher Summa
- Development of M16A2 Pivoting Coupling
  - Mr. Matthew Millar

40mm Technology Advancement Benefits

- **Rigorous In-Depth Engineer Rationale and Design/Performance Data Base Evolving for all 40mm Ammunition**
  - **Baseline Design/Performance Evolving**
- **Attention to Implementing Priority Product Improvements**
  - **Development (New Technology, Components, Cartridges)**
  - **Addressing Producibility Topics**
  - **Technology Insertion**
- **Linking the 40mm Government and Contractor Community**
  - **Effective IPT Teams**

Supporting the Warfighter Objectives
40mm Ammunition
Capability, Quality, Reliability, Availability, and Affordability
Today and the Future

LtCol George M. Chinn Award



Mr. Troy Smith

2008 NDIA LtCol George M. Chinn Award Recipient

MK 12

MK 11

MK 18

MK 23

MK 46

MK 48

MK 16

MK 17

MK 13

SOF WEAPONS


PM
EX16 MOD 0 (SCAR-L)
SOF Combat Assault Rifle (Light)


PM
EX17 MOD 0 (SCAR-H)
SOF Combat Assault Rifle (Heavy)


PM
EX 13 MOD 0
Enhanced Grenade Launcher Module
EGLM


IN
MK12 MOD 1
Rifle, Special Purpose, 5.56mm
1005-01-504-3276


MK18 MOD 0
Close Quarters Combat Carbine CQBR
1005-01-527-2288


IN
MK11 MOD 0
Rifle, Sniper 7.62mm
1005-01-475-7980


PE
MK23 MOD 0
Pistol, .45 Cal
1005-01-426-8951


PM
MK46 MOD 1
Machine Gun, Lightweight, 5.56mm
1005-01-534-3682


PM
MK48 MOD 1
Machine Gun, Lightweight, 7.62mm
1005-01-539-4164


MK47 MOD 0
Advanced Lightweight
Grenade Launcher, 40mm
1010-01-522-3257


IN
MK13 Rifle, .300 WINMAG
MOD 0: 1005-LL-L99-5364
MOD 1: 1005-LL-L99-5477
MOD 2: 1005-01-523-4611


MK15 MOD 0
Rifle, Special Application Sniper .50 Cal
1005-01-525-7716


M3 Carl Gustaf
Multi-role Antiarmour Antipersonnel
Weapon System MAAWS
1015-01-314-1770

Troy Smith's Involvement
PM: Program Manager, PE: Project Engineer, IN: Instrumental

NSWC Crane Division
Point Of Contact
sofsustainment@navy.mil

Also

- M4A1
- MK262
- SOPMOD
- SOF Weapons PM
- Enhanced "O" Level Maintenance + VAS
- Enhanced SOF ammo (5.56x45mm, 7.62x51mm, 40x46mm MV, .300 Win Mag)
- Future Sniper Rifle System

NDIA NATIONAL DEFENSE INDUSTRIAL ASSOCIATION

LtCol George M. Chinn Award

Troy Smith

Awards and Recognition

MK 12

MK 11

- 2001 USSOCOM "FCT Program of the Year" Award

MK 18

MK 23

- 2001 "David Packard" Award
- 2003 US Navy Meritorious Civilian Award
- 2004 NDIA OSD Govt "Tester of the Year" Award

MK 46

MK 48

- 2007 CTO Program "Manager of the Year" Award

MK 16

MK 17

MK 13

NDIA NATIONAL DEFENSE INDUSTRIAL ASSOCIATION

LtCol George M. Chinn Award

Mr. Troy Smith

2008 Chinn Award Recipient

MK 12

MK 11

MK 18

MK 23

MK 46

MK 48

SUPPORTING THE NEEDS OF THE WAR FIGHTER TODAY

MK 16

MK 17

MK 13

Product Manager Individual Weapons Overview

For the

Small Arms Symposium & Exhibition

National Defense Industrial Association

19-22 May 2008

BG R. Mark Brown
Program Executive Officer Soldier

LTC Tim Chyma
PM Individual Weapons

Individual Weapons

XM25 Individual Airburst Weapon System

DESCRIPTION

A semi-automatic rifle with an integrated target acquisition fire control that fires 25mm air bursting munitions.

ACQ STRAT: Developmental

QTY: TBD

PHASE: Technology Development

CONTRACTOR: Alliant Techsystems, Plymouth, MN; L3 Communications (Brashears), Pittsburgh, PA; H&K, Oberndorf, GM

CAPABILITIES

- **Defeats defilade targets**
- **Family of 25mm ammunition**
  (includes HEAB, TP, AP, non-lethal)
- **500 meter point targets**
- **500-700 meters area targets**
- **Fully integrated target acquisition / fire control**
  (2x Thermal, 2x DVO, LRF, compass, fuze setter, ballistic processor, and internal display)

FUTURE KEY EVENTS

- **Contractor / Government testing**
- **Early User Assessment**
- **MS B**

XM26 Modular Accessory Shotgun System (MASS)

DESCRIPTION

A lightweight accessory shotgun system that attaches under the barrel of the M4 and M16 Modular Weapon Systems.

ACQ STRAT: COTS/NDI

QTY: Tentatively 26,789

PHASE: Low Rate Initial Production

CONTRACTOR: Vertu Corp

CAPABILITIES

- **Fires Lethal, Non-lethal and Door Breaching 12 Ga. Rounds**
- **Can be zeroed to the sighting system of the host weapon**
- **Lethality equivalent of a stand-alone 12 Ga. Shotgun**
- **Can be fired as a stand-alone weapon**

FUTURE KEY EVENTS

- **Complete DT/OT Testing**
- **Production Decision**
- **Fielding**

XM320 Grenade Launcher Module (GLM)

DESCRIPTION

A 40mm grenade-launching weapon module that will replace M203 series grenade launchers currently mounted on the M16/M4 series of rifles and carbines.

ACQ STRAT: COTS/NDI

QTY: Tentatively 71,600

PHASE: Low Rate Initial Production

CONTRACTOR: Heckler & Koch Defense Inc.

CAPABILITIES

- **Integral Day/Night sighting system improves target acquisition and accuracy**
- **Improved Reliability and Safety**
- **Can be fired as a stand-alone weapon**
- **Unrestricted breach allows a wider array of munitions**

FUTURE KEY EVENTS

- **Production Decision**
- **Fielding**

M150 Rifle Combat Optic (RCO)

DESCRIPTION

A magnified optic that attaches to M4s, M16s and M249s to improve the ability to recognize and engage targets out to 600m.

ACQ STRAT: COTS/NDI

QTY: Tentatively 135,091

PHASE: Production and Deployment

CONTRACTOR: Trijicon

CAPABILITIES

- **Improved capability to recognize and engage targets 0-600m.**
- **Allow Soldier to rapidly transition between close quarter and long-range engagements.**

FUTURE KEY EVENTS

- **Material Release**
- **Continue Fielding**

M68 Close Combat Optic (CCO)

DESCRIPTION

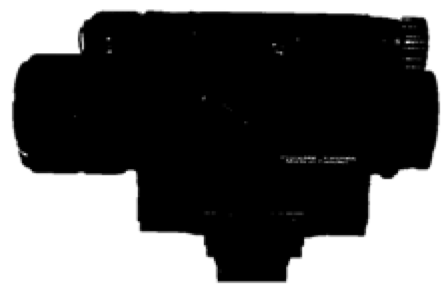
A unity powered red dot sight that attaches to M4s and M16s for close quarter engagements.

ACQ STRAT: COTS/NDI

QTY: 565,000

PHASE: Production (Recompete)

CONTRACTOR: TBD



CAPABILITIES

- **Allows the Soldier to engage targets with both eyes open while maintaining situational awareness**
- **Eliminates the difficulty associated with aligning irons sights.**

FUTURE KEY EVENTS

- **Contract Award**
- **DT/OT Testing**
- **Full Rate Production Decision**

Upcoming Competitive Opportunities

- Modular Handgun System
  - COTS/NDI approach
  - Performance based competition
  - Anticipate Fall '08

- Carbine
  - Compete the M4 design Tech Data Package
  - Anticipate multiple contract awards for end item and parts
  - Anticipate Summer '09

- Special Compact
  - COTS/NDI approach
  - Performance based competition
  - TBD pending approval of requirement and funding

Monitor procnet at http://procnet.pica.army.mil

Entry Points For Innovative Ideas

- Soldier Enhancement Program (SEP)
  - Identify and evaluate COTS/NDI items that are used by the individual Soldier in a tactical environment and can be adopted and provided to Soldiers in three years or less.
  - Anyone can submit a SEP proposal
  - The proposal must meet SEP criteria
  - Visit https://www.peosoldier.army.mil/sep.asp
- Unsolicited Proposal (UP)
  - A new idea, suggestion or inventive concept that is offered outside formally advertised requests
  - The Army has a continuing interest in receiving and evaluating UPs
  - Unsolicited proposals must meet UP criteria
  - Visit https://www.pica.army.mil/techtran/howtodo/default.htm
  - Or call the technical and Industrial liaison Officer at 973-724-6750

2008 International Infantry & Joint Services Small Arms Systems Symposium & Expo

Small Caliber Ammunition Industrial Base Past-Present-Future

21 May 2008

Dave Council
Director, Military Program Management
Olin Corporation, Winchester Division
dwcouncil@olin.com
(618) 258-3511

Agenda

- **Winchester Overview**
- **The Past (2000 to 2003)**
  Before OEF & OIF
- **The Ramp-Up (2004 to 2006)**
  Urgent Buys and Second Source Start-Ups
- **The Present**
  (Almost) All Systems Go
- **The Future**
  Flexibility Required

Winchester Overview

- Winchester is in its 142nd year of operation and its 78th year as part of Olin Corporation.
- Winchester is a premier developer and manufacturer of small caliber ammunition for sale to domestic and international retailers, law enforcement agencies, and domestic and international militaries.
- Winchester is committed to conservation, the shooting sports, our nation's hunting heritage, and support of the American Warfighter.

Core Businesses

Winchester Ammunition

Military
Primary Ammunition Products:
Centerfire rifle, centerfire pistol, and and buckshot for US and foreign military operations

Law Enforcement
Primary Ammunition Products:
Centerfire pistol, centerfire rifle, slugs & buckshot for federal, state, and municipal law enforcement agencies

Industrial
Primary Ammunition Products:
8 Gauge and rimfire PAT for industrial plants and the construction industry

Commercial
Primary Ammunition Products:
Shotshells, centerfire rifle, centerfire pistol, and rimfire For hunters and recreational target shooters

Operations

Winchester Plant Site	Products Produced
East Alton, Illinois	Shotshells Small caliber centerfire rifle & pistol cartridges Industrial products: 8 gauge shotshells
Oxford, Mississippi	Rimfire ammunition Powder-actuated tool (PAT) loads
Geelong, Australia	Shotshells Small caliber centerfire rifle & pistol cartridges Rimfire ammunition Powder-actuated tool (PAT) loads

The Past: 2000 to 2003

- Base Military Business at East Alton, IL Facility
  - Well Established; Long History of US Government Supply
  - Prime Contracts for Pistol, Shotshell, Rimfire, Specialty Loads
  - Manufacturing Capacity Shared to Meet Demands of All Markets
- Market Conditions for Military Small Cal Ammo Were Down
  - Just Past the Low Point of ’90s Drawdown
  - Weakened Second Tier Sub-contractor Base
  - Room to Grow

The Ramp Up (2004 to 2006)

- “Urgent Buy” Contracts Awarded 2003 & 2004
  - Prime Contracts for “Lake City” Line Items (5.56mm, 7.62mm and .50 Cal)
  - Full US TDP Compliance, with Minimum Tolerance for Exceptions
  - Demanding Start-up and Delivery Schedules
  - Utilized Manufacturing Capacity Available from Total Plant Pool
- “Second Source” Contract Awarded to GD-OTS in 2005
  - Winchester Sub-contractor on GD-OTS Team
  - Continuation and Addition of Products
  - Essentially Zero Tolerance for Exceptions to US TDP
- Lessons & Adjustments
  - Demands of Multiple New Product Start-ups (Equipment Set-up; Process Development; Employee Training; Supply Base Development; FATs; etc.)
  - New Quality Requirements (MIL STD 1916; Critical Defect Clauses; ISO 9001:2000; etc.)
  - New Customer Dynamic (PEO; PM-MAS; Critical Need)

The Present

- **Winchester is in its Fifth Year of Elevated Production**
  - **Start-ups Complete**
  - **Workforce Trained – *Ongoing***
  - **“Government Business” Culture Established – *Ongoing***
  - **Supply Base Established & Stabilized**
  - **Readiness at Peak Level**

The Future

- Variables & Uncertainty – Politics & Budgets
- Potential Cost Impact of Commodities Must be Mitigated (Current ICAP Project with EPA Clauses)
- Readiness Achieved From Five Years of Investments In Human Capital, Equipment and Processes Should be Maintained
- Requirements (and Funding) Should be Established to Maintain Minimum Sustaining Production Rates
- If/When Drawdown Occurs:
  - Business Will Follow the Dollars
  - Winchester Capacity Will Redirect to Other Market Demands
  - Readiness Will Suffer
  - Start-up Costs will be Incurred Again During Next Ramp-up
  - Effects Amplified in A “Hard Landing” Scenario

Joint Service Small Arms Applied Research Activities and Approach

2008 National Defense Industrial Association's International Infantry & Joint Services Small Arms Systems Symposium

Joint Service Small Arms Program Office
John Edwards
Program Management Officer

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Outline

Approach - Joint Service Small Arms

Applied Research efforts

Warfighter focus

All photographs are from the DOD link photos page

Joint Service Small Arms Program

- Harmonizes/Coordinates Across Armed Services

  JSSAP Mission

- Consolidated Small Arms Science & Technology

  JSSAP Mission

  - Operational Based
  - PM Technology List (*total ownership cost*)

- Joint Small Arms Master Plan Updated every 2 years

  JSSAP SOP

Joint Service Small Arms Synchronization Team is the reviewing and approving authority

JSSAP Tech Plan
Approach and Coordination

1. Capability Assessments and Needs reviewed
   - Service Combat Developers
   - Joint collaboration and/or assessment
2. NSAC/NSATC subcommittees review of white papers
   - JSSAP Application Working Group as subcommittee
3. Coordination with OGAs either directly or through NSAC subcommittees.
   - Coordinate with other Lethality Technology Investments, ATOs.
4. Joint Service Small Arms Synchronization Team approval
5. Additional Reviews; RDEC Lethality IPT, RDECOM, ONR, ASAALT

RDECOM

Small Arms Tech Planning

FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14

Lightweight Small Arms Technology

Caliber Study

Technology for Small Arms Capabilities

- **Lethality (ex. Miniature prox fuze components; Frag improvements)**
- **Advanced materials & recoil technologies**
- **Fire Control Tactile Range determination component**
- **Powered rail technologies & Wireless weapons interface**

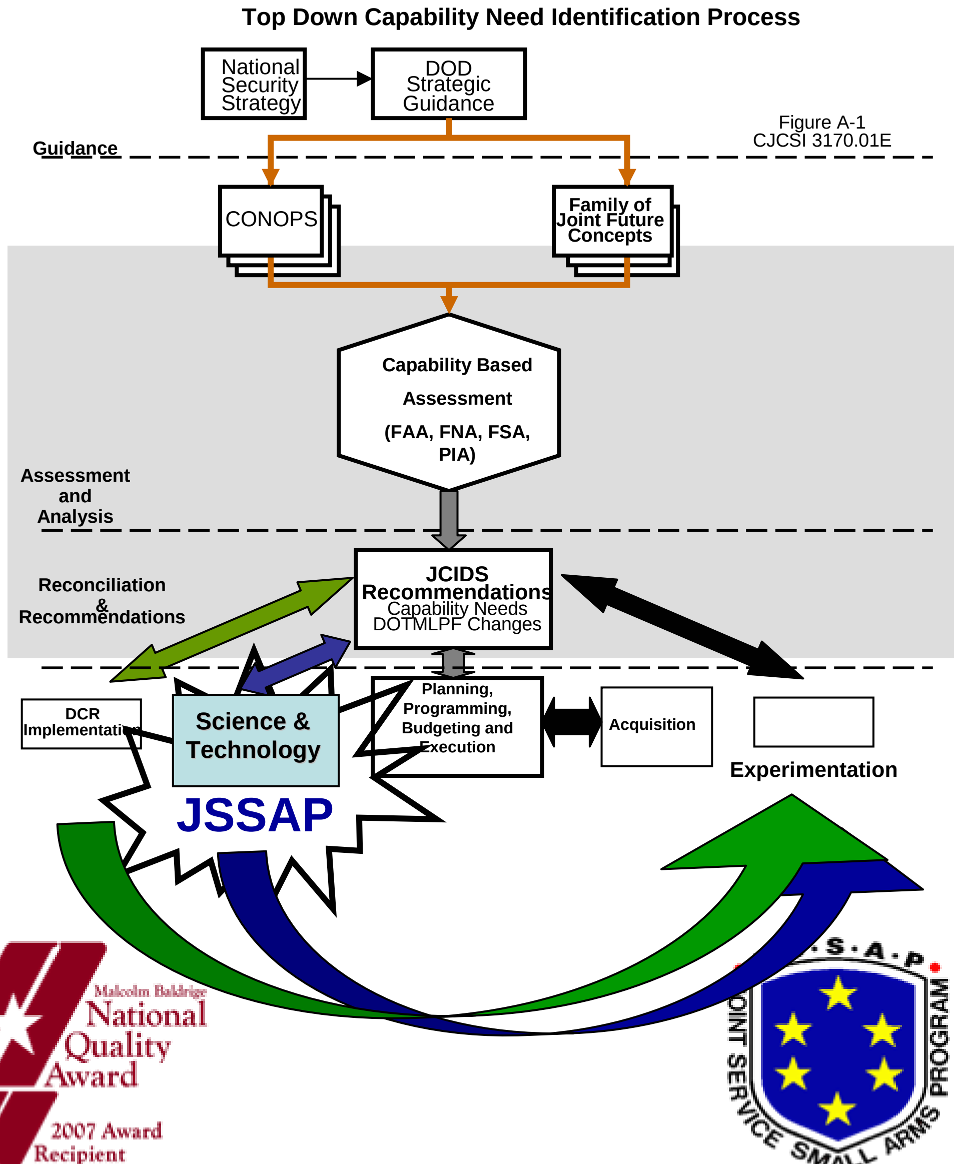
Small Arms New Concepts & Technology Capabilities

Malcolm Baldrige National Quality Award 2007 Award Recipient

J.S.S.A.P. JOINT SERVICE SMALL ARMS PROGRAM

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

JSSAP Tech Plan Implementation



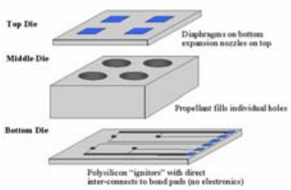
Small Arms Capability Based Assessment most recent JCIDs small arms update.

✓ *Enhancing the warfighters overmatch capability*

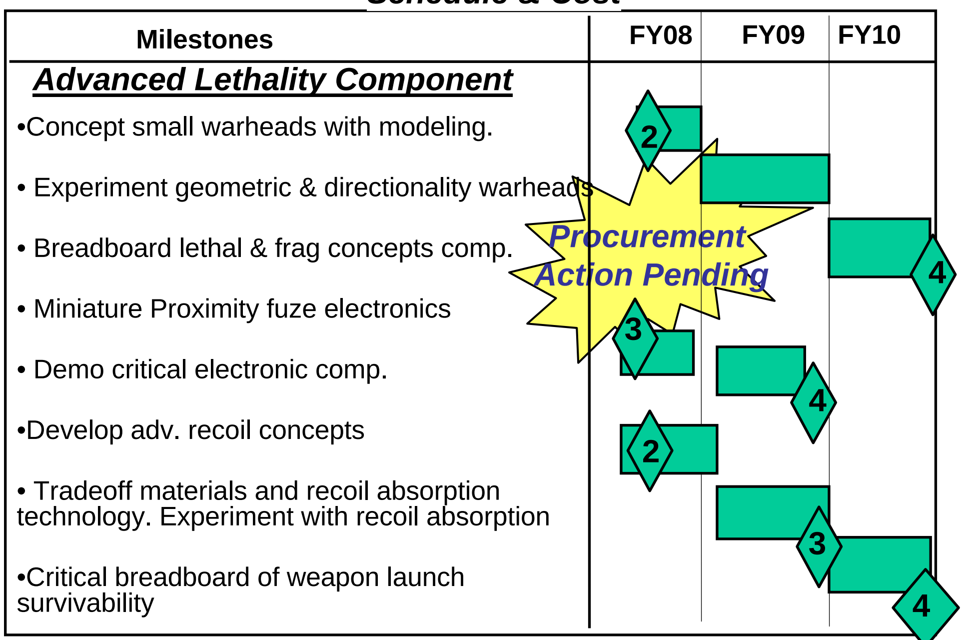
RDECOM

Advanced Lethal Armament Technology Small Arms

Army Technology Objective *R.ARD.2008.03*



Schedule & Cost



Purpose:

– *To demonstrate advanced lethal armament component technology*
– *Terminal fragmentation effectiveness trades*
–*Miniaturize Proximity electronics power*
– *Lowest weight Recoil attenuation*
– *Modeling and Simulation assessments*

Payoff:

- ***Provides improved munition effectiveness to targets***
- ***Multiple critical technology demonstrations***
- ***Enabling maturity measurement***
- ***Systems level analysis***

Supporting fulfilling broad small arms capability gaps for spiral transition.

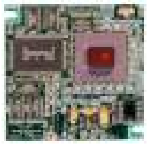
Malcolm Baldrige National Quality Award
2007 Award Recipient

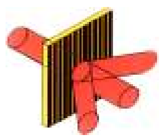
J.S.S.A.P. JOINT SERVICE SMALL ARMS PROGRAM

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

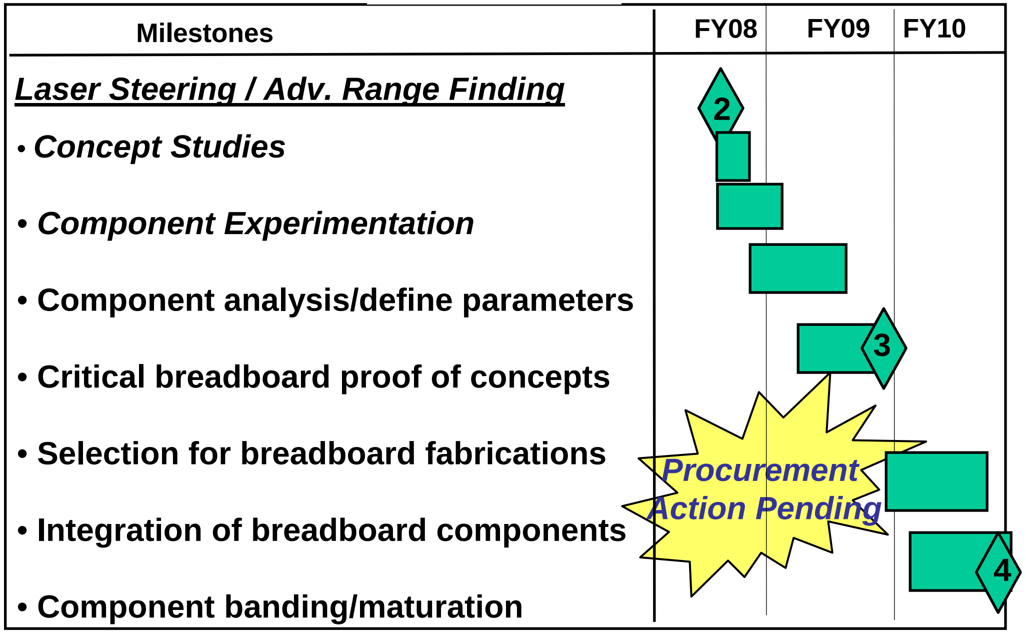
Army Technology Objective *R.ARD.2008.054*

Target Tracker & **Laser steering**





Schedule & Cost



Purpose:

– ***To demonstrate advanced fire control component technology***

– ***Determining correct range to moving targets***

– ***Further power sharing within weapon***

Payoff:

- ***Critical technology demonstrations***
- ***Technology maturity TRL path***
- ***Integration Systems Analysis***
- ***Available for spiral transition***

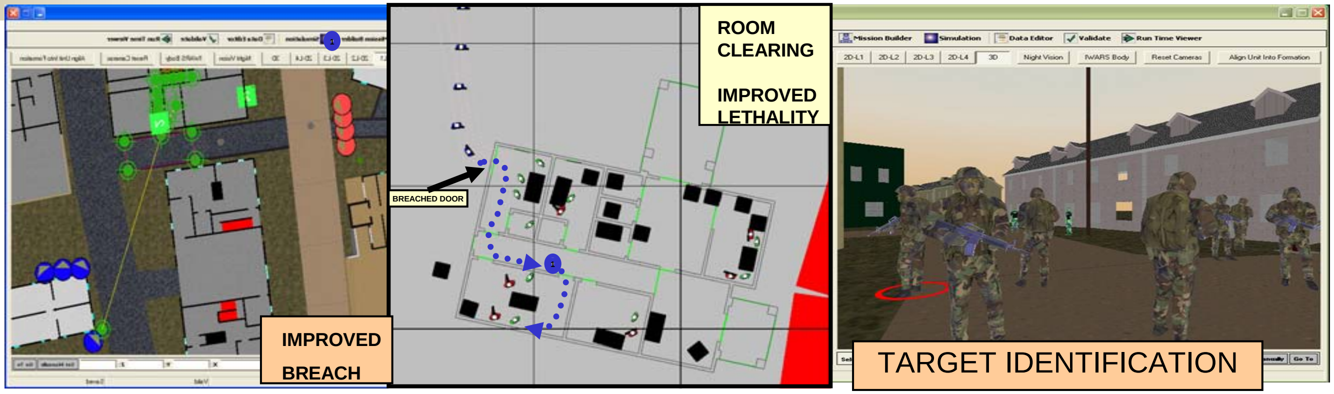
Supporting fulfilling broad small arms capability gaps defilade and covered targets

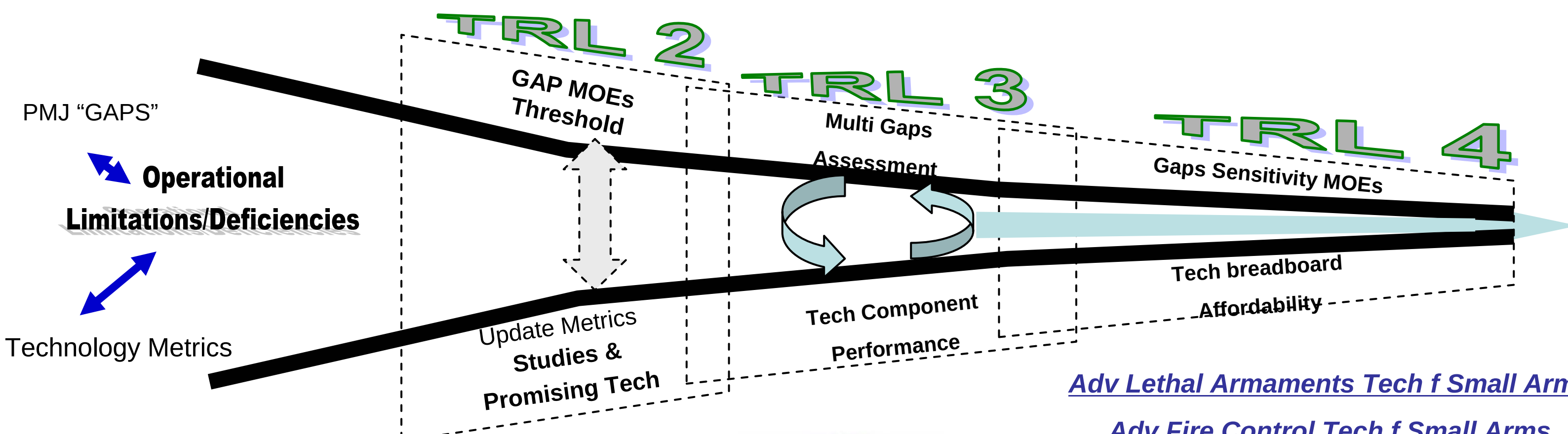
Malcolm Baldrige National Quality Award 2007 Award Recipient

J.S.S.A.P. JOINT SERVICE SMALL ARMS PROGRAM

Modeling and Simulation Role in JSSAP ATO's

Operational Requirements

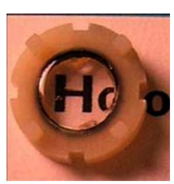


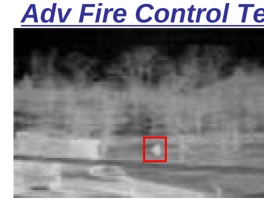


Adv Lethal Armaments Tech f Small Arms

Adv Fire Control Tech f Small Arms

Applied Research





Malcolm Baldrige National Quality Award 2007 Award Recipient

J.S.S.A.P JOINT SERVICE SMALL ARMS PROGRAM

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Outcomes of Applied Tech Programs

Technology Component Investments

- Warfighter Capability focus
- Critical Technology Demonstrations
- System Analysis Effectiveness

Modeling and Simulation activities

- ➢ Link to Capabilities
- ➢ Integration to weapons systems
- ➢ Underpinning analysis documented

Procurement Actions Pending

Summary

Approach - Joint Service Small Arms

Warfighter Capability Focus

Applied Research efforts

Modeling and Simulation links Capabilities to technologies

SDE

Suppressing Sacred Cows

Graham Evenden

Director – Business Development

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E-mail: Graham@SystemDesignEvaluation.co.uk
www.SystemDesignEvaluation.co.uk

...Adding Value...

Outline

- Introduction.
- Targetry – From data through information to knowledge!
- Trial Results – A platform for improving shooting training?
- Reconciling Training Expectations & Trial Results.

SDE Location & Core Activities

...Adding Value...

The SDE Team

SDE

...Adding Value...

Our Customers

SDE

Forsvarets forskningsinstitutt

de&s

Cranfield UNIVERSITY

Nammo

QinetiQ

DSTA
Defence Science & Technology Agency

[dstl]

RHEINMETALL

QIOPTIQ
Optics with Intelligence

Qioptiq Imaging Solutions

RUAG
Aerospace Defence Technology

THALES NAVAL

BAE SYSTEMS

Lloyd's Register

VT Group

SUPACAT

DML
DEVONPORT

Australian Government
Department of Defence
Defence Science and Technology Organisation

MSI-Defence Systems Ltd

...Adding Value...

Live Fire Intelligent Target

LFIT

LIVE FIRE INTELLIGENT TARGETS

Brief History






...Adding Value...

Characteristics – Shot Detection

SDE

- Accurate detection of high velocity projectiles.
- Detection window 30m x 30m(Calibre and Sensitivity Setting Dependent).
- Detection (HV) up to 45^{O} from either side of target centre.
- Radio Controlled (3 -4 km) & GPS for UTC.
- PC at every target for instant decision making and subsequent target behaviour.
- Allows sufficient scope for most realistic trial scenarios and LFTT.

Live Fire Intelligent Target (LFIT)

SDE

LIVE FIRE INTELLIGENT TARGETS

...Adding Value...

Live Fire Intelligent Target (LFIT)

SDE

The 'intelligent' targets capture the time and position (in 3D-space) of all shots that pass within close proximity to the target. The software processes this information to determine whether that specific shot would have resulted in a

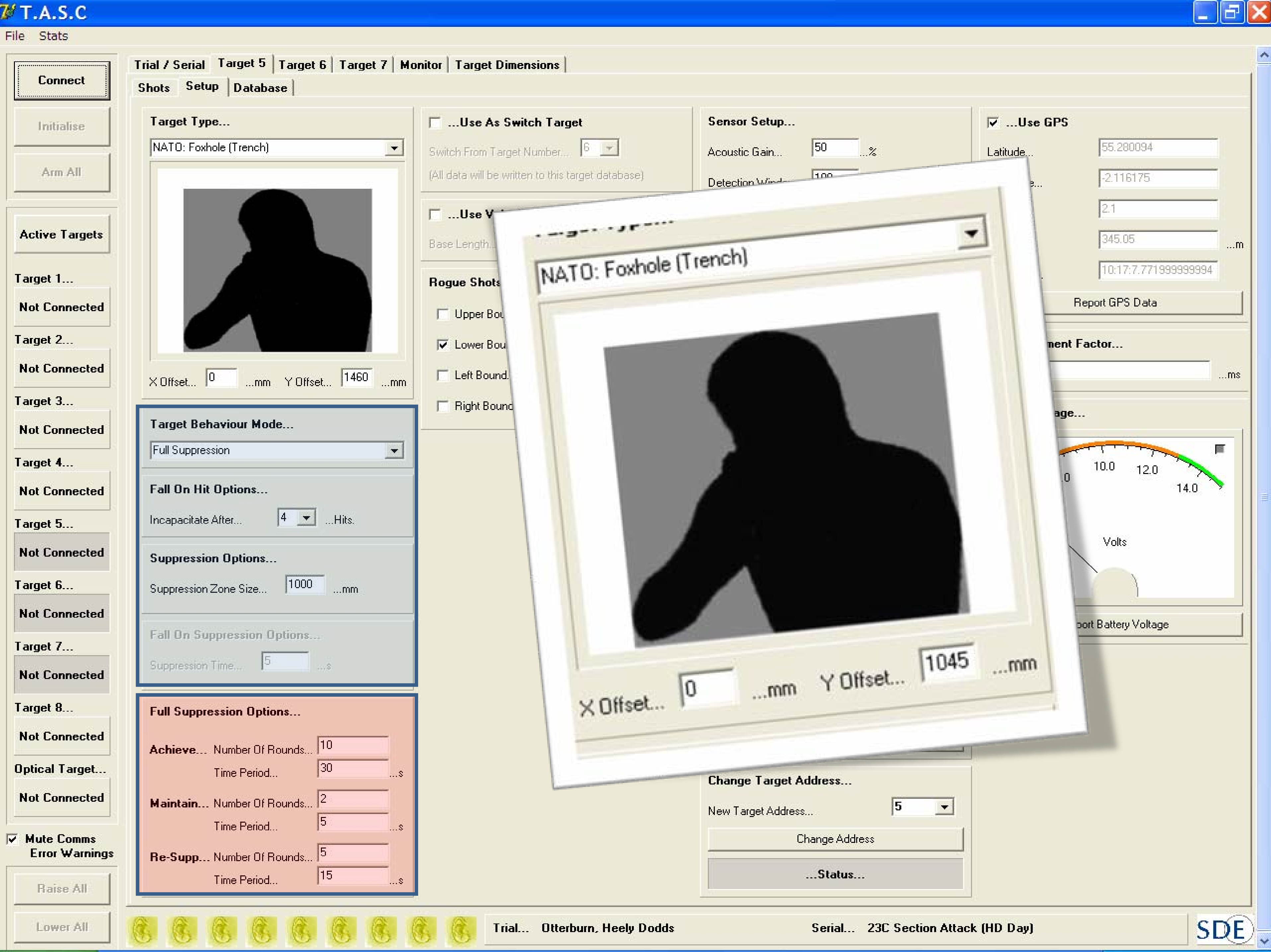
kill,

incapacitation

or suppressive effect

The LFIT simulate the response of a potential enemy to the effectiveness of the incoming fire from the exercising troops and the targets respond 'intelligently' to the incoming fire, in an autonomous manner

...Adding Value...


T.A.S.C
File Stats
Connect
Initialise
Arm All
Active Targets
Target 1...
Not Connected
Target 2...
Not Connected
Target 3...
Not Connected
Target 4...
Not Connected
Target 5...
Not Connected
Target 6...
Not Connected
Target 7...
Not Connected
Target 8...
Not Connected
Optical Target...
Not Connected
Mute Comms Error Warnings
Raise All
Lower All
Trial / Serial
Target 5
Target 6
Target 7
Monitor
Target Dimensions
Shots
Setup
Database
Target Type...
NATO: Foxhole (Trench)
X Offset... 0 ...mm Y Offset... 1460 ...mm
Target Behaviour Mode...
Full Suppression
Fall On Hit Options...
Incapacitate After... 4 ...Hits
Suppression Options...
Suppression Zone Size... 1000 ...mm
Fall On Suppression Options...
Suppression Time... 5 ...s
Full Suppression Options...
Achieve... Number Of Rounds... 10
Time Period... 30 ...s
Maintain... Number Of Rounds... 2
Time Period... 5 ...s
Re-Supp... Number Of Rounds... 5
Time Period... 15 ...s
...Use As Switch Target
Switch From Target Number... 6
(All data will be written to this target database)
Base Length...
Rogue Shots
Upper Bou
Lower Bou
Left Bound
Right Bound
Sensor Setup...
Acoustic Gain... 50 ...%
...Use GPS
Latitude...
55.280094
-2.116175
2.1
345.05
...m
10:17:7.771999999994
Report GPS Data
...ms
10.0
12.0
14.0
Volts
Change Target Address...
New Target Address... 5
Change Address
...Status...
NATO: Foxhole (Trench)
X Offset... 0 ...mm Y Offset... 1045 ...mm
Trial... Otterburn, Heely Dodds
Serial... 23C Section Attack (HD Day)
SDE

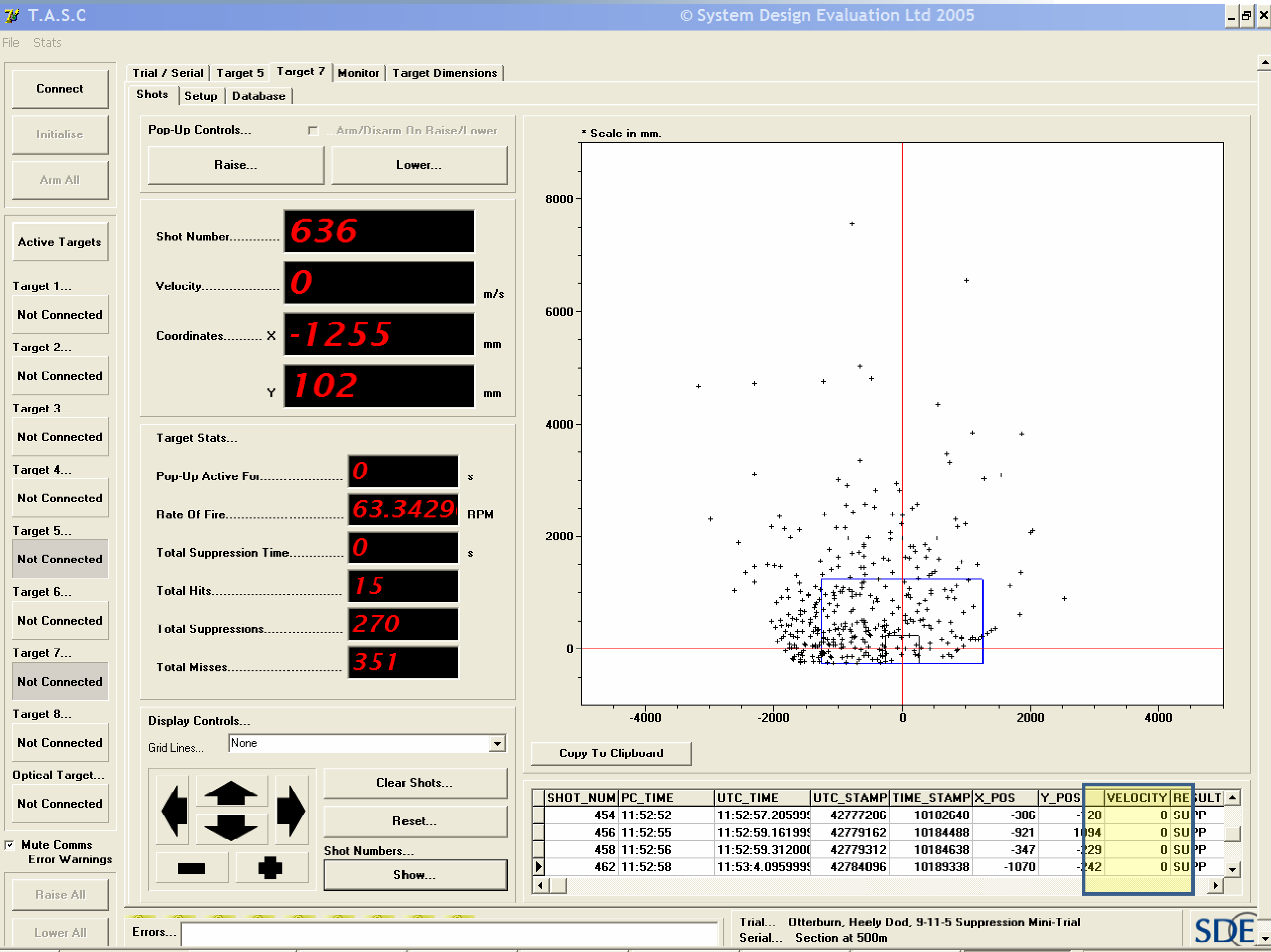

SDE
Target Behaviour Mode...
Full Suppression
Fall On Hit Options...
Incapacitate After...
10
...Hits.
Suppression Options...
Suppression Zone Size...
1000
...mm
Fall On Suppression Options...
Suppression Time...
5
...s
...Adding Value...

SDE

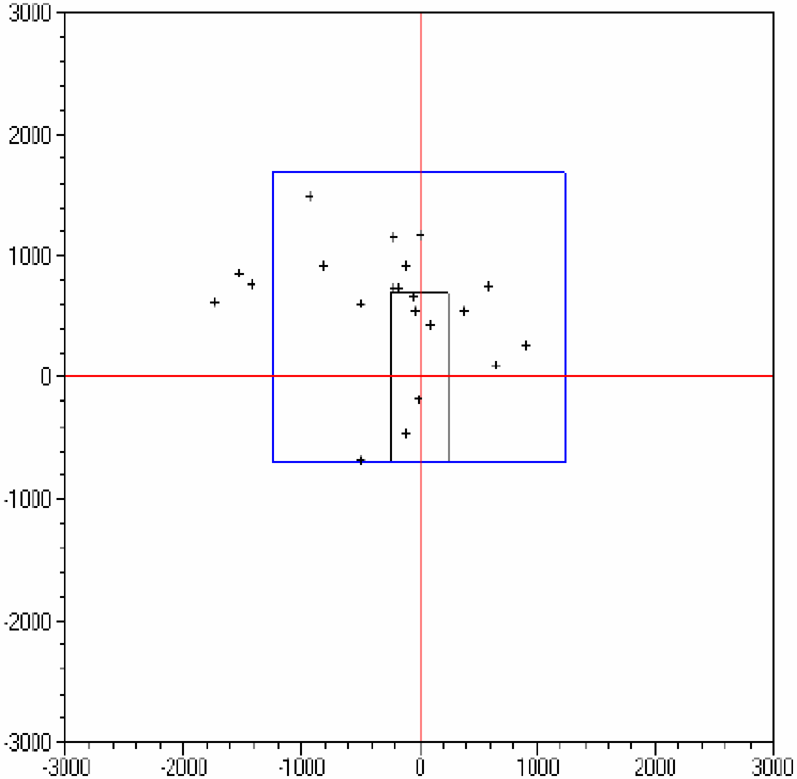
Full Suppression Options...

Achieve...	Number Of Rounds...	2	
	Time Period...	15	...s
Maintain...	Number Of Rounds...	1	
	Time Period...	5	...s
Re-Supp...	Number Of Rounds...	2	
	Time Period...	15	...s

...Adding Value...


T.A.S.C
© System Design Evaluation Ltd 2005
File
Stats
Connect
Initialise
Arm All
Active Targets
Target 1...
Not Connected
Target 2...
Not Connected
Target 3...
Not Connected
Target 4...
Not Connected
Target 5...
Not Connected
Target 6...
Not Connected
Target 7...
Not Connected
Target 8...
Not Connected
Optical Target...
Not Connected
Mute Comms Error Warnings
Raise All
Lower All
Trial / Serial
Target 5
Target 7
Monitor
Target Dimensions
Shots
Setup
Database
Pop-Up Controls...
...Arm/Disarm On Raise/Lower
Raise...
Lower...
Shot Number.............. 636
Velocity.............. 0 m/s
Coordinates.......... X -1255 mm
Y 102 mm
Target Stats...
Pop-Up Active For...................... 0 s
Rate Of Fire........................ 63.3429 RPM
Total Suppression Time.............. 0 s
Total Hits........................ 15
Total Suppressions...................... 270
Total Misses........................ 351
Display Controls...
Grid Lines... None
Clear Shots...
Reset...
Shot Numbers...
Show...
* Scale in mm.
8000
6000
4000
2000
0
-4000
-2000
0
2000
4000
Copy To Clipboard
SHOT_NUM PC_TIME UTC_TIME UTC_STAMP TIME_STAMP X_POS Y_POS VELOCITY RESULT
454 11:52:52 11:52:57.28599 42777286 10182640 -306 28 0 SUPP
456 11:52:55 11:52:59.16199 42779162 10184488 -921 1094 0 SUPP
458 11:52:56 11:52:59.31200 42779312 10184638 -347 29 0 SUPP
462 11:52:58 11:53:4.09599 42784096 10189338 -1070 42 0 SUPP
Errors...
Trial... Otterburn, Heely Dod, 9-11-5 Suppression Mini-Trial
Serial... Section at 500m
SDE

Shots Display...



Trial Name...	Section Attack Night 1 Nov
Serial Number...	21
Date...	01/11/2005

SDE

Target... 2

Primary Target

Parameters...

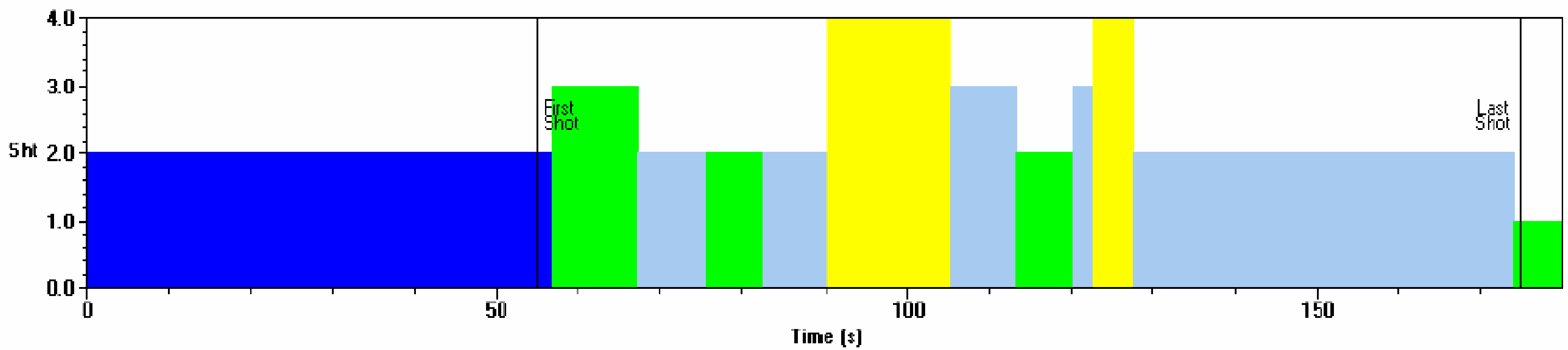
Suppression Zone Size (mm):	1000
Hits To Incapacitate:	10
Achieve...	
Number Of Rounds:	2
Time Period (s):	15
Maintain...	
Number Of Rounds:	1
Time Period (s):	5
Re-Establish...	
Number Of Rounds:	2
Time Period (s):	15

Stats...

Serial Length (s):	218.33
Engagement Time (s):	54.96
Time To Initial Suppression:	56.77
Time To Last Shot (s):	174.93
Time To Incapacitation (s):	N/A
Time Suppressed (s):	50.05
Time Unsuppressed (s):	129.88
Time Suppressed (%):	27.82
Time Unsuppressed (%):	72.18
Total Shots Recorded:	22
Total Hits:	4
Total Suppressions:	14
Total Misses:	4
Total Shots After Incapacitation:	N/A

Suppression Timeline...

Key: Achieving Suppression | Maintain Suppression | Maintain Suppression (No Shots) | Re-establishing Suppression | Incapacitated



Measures Of Effect (MOE)

SDE

- Time to engage enemy;
- Time to achieve initial suppression;
- Duration of suppressive period provided by ammunition load;
- Proportion of shots that are deemed to have some effect upon the enemy;
- Proportion of task duration for which the enemy was suppressed;
- Time to kill the enemy;
- Rounds to kill the enemy.

SDE

Lethality Trial Results

and

Operational Shooting Requirement

(OSR)

Infantry (Individual)

SDE

The Infantry soldier must be able to react quickly and to fire accurately to kill or suppress an enemy to the limits of the battle range of his personal weapon, or at close quarters, from different static positions, on the move and from cover.

Reference: UK AOSP Chapter 1

...Adding Value...

Infantry (Fire Team)

SDE

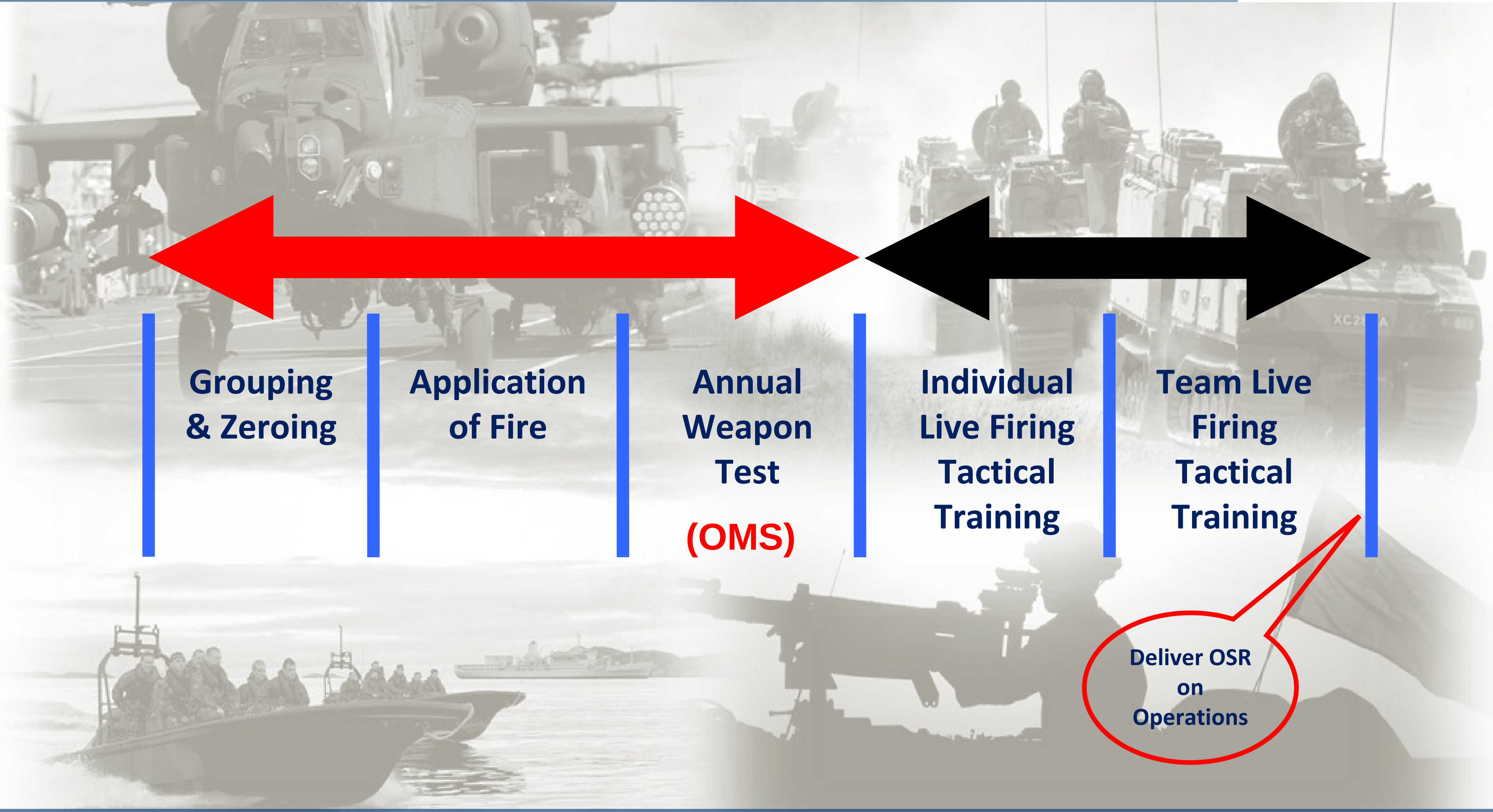
Four-man teams must be able to kill or suppress an enemy in defence and in offensive operations at battle ranges to 600 metres.

Reference: UK AOSP Chapter 1

...Adding Value...

Current Process

SDE



...Adding Value...

Measures Of Performance (MOP)

SDE

- **The Operational Marksmanship Standards (OMS) are Measures Of Performance.**
- **The Measured Performance is to achieve:**

(h) % hits

at (r) range

on (t) target

Current Process

Grouping & Zeroing

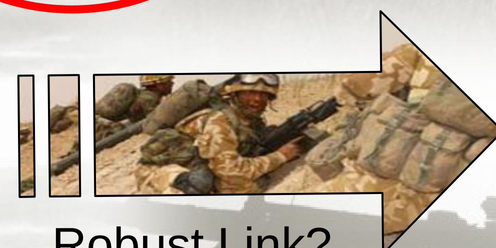
Application of Fire

Annual Weapon Test

OMS=MOP

Individual Live Firing Tactical Training

Team Live Firing Tactical Training



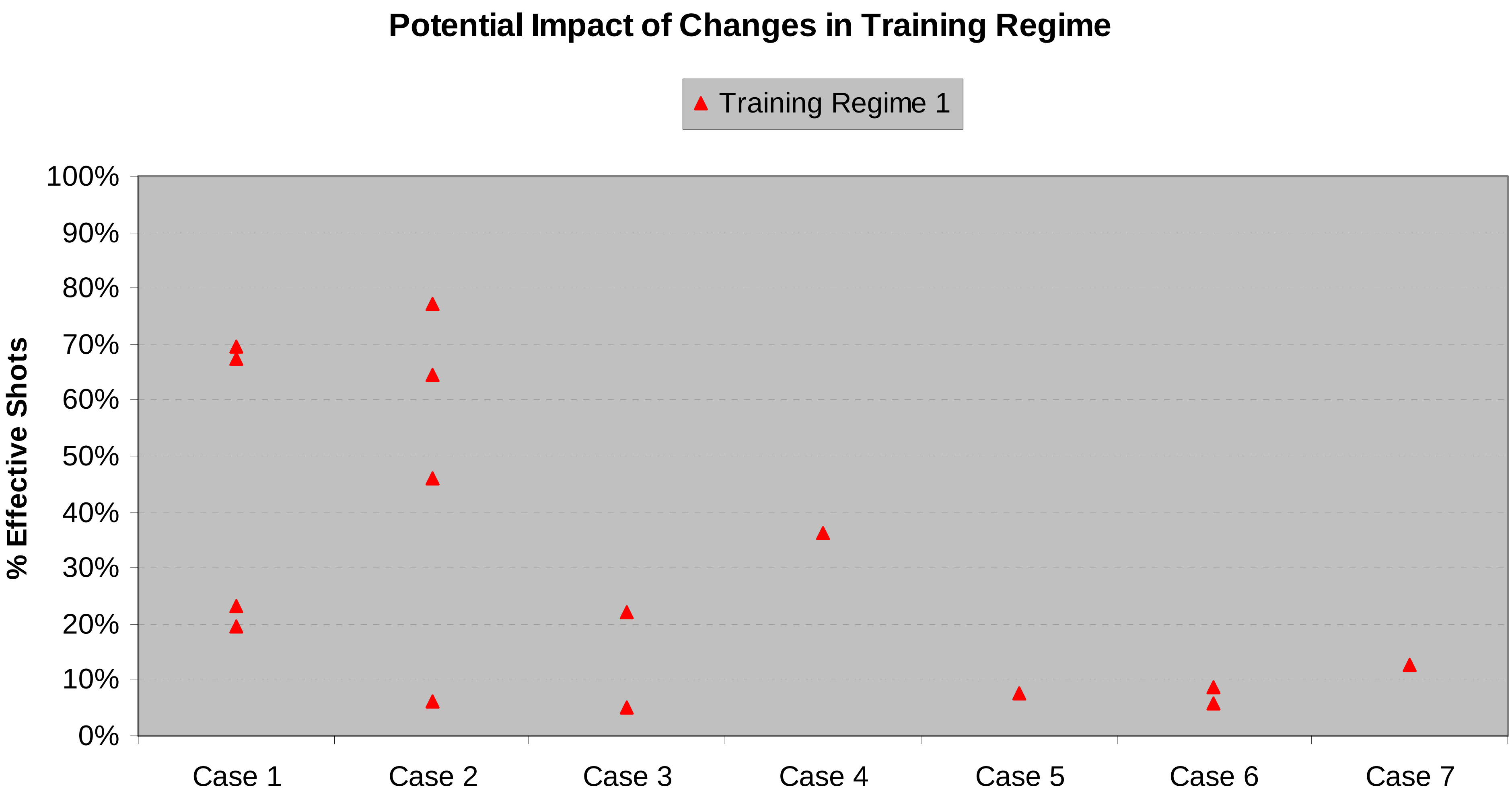
Robust Link?

Delivery of Effect

Achieve OMS = Deliver OSR

Trial Results

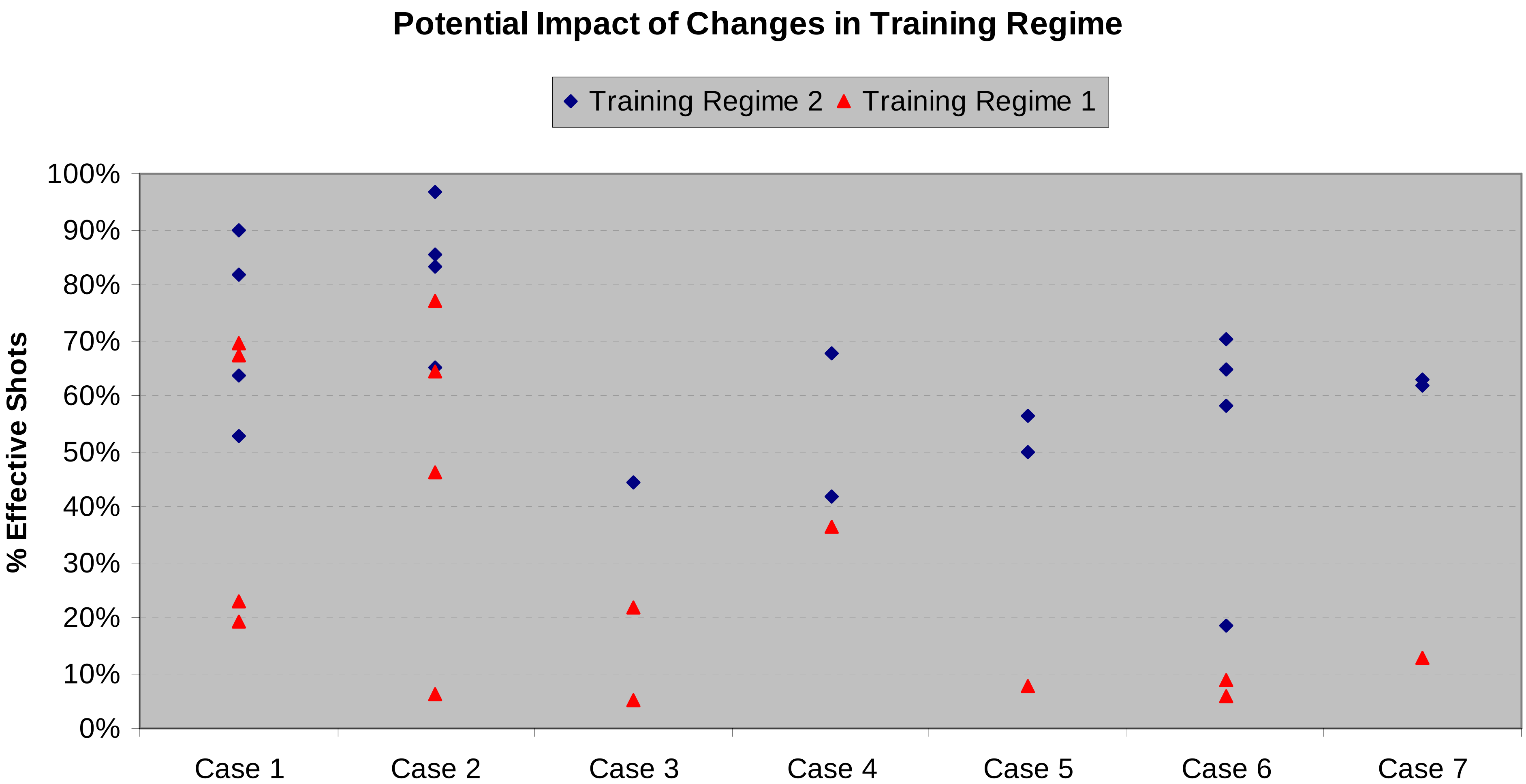
SDE



...Adding Value...

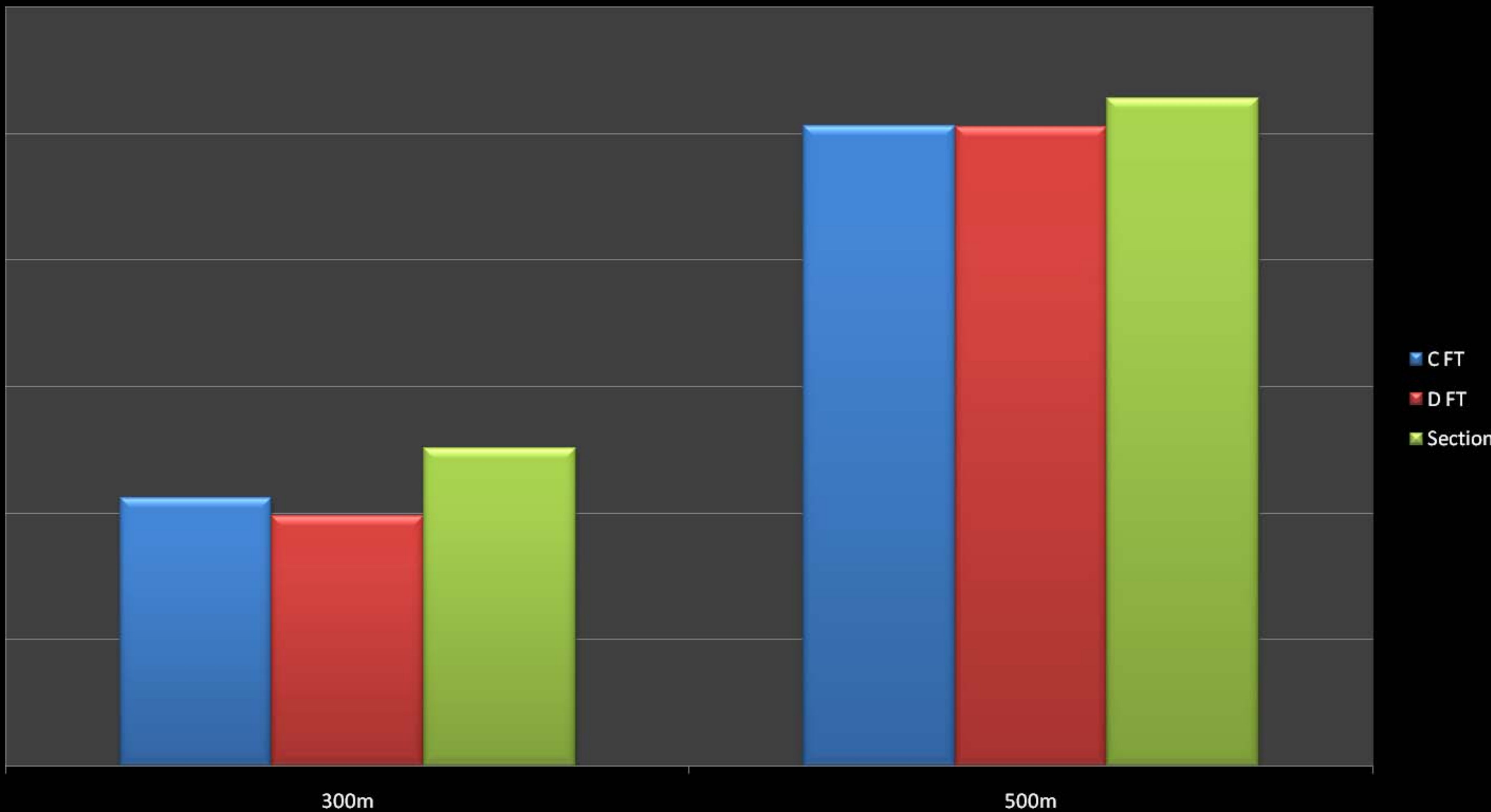
A Different Approach

SDE



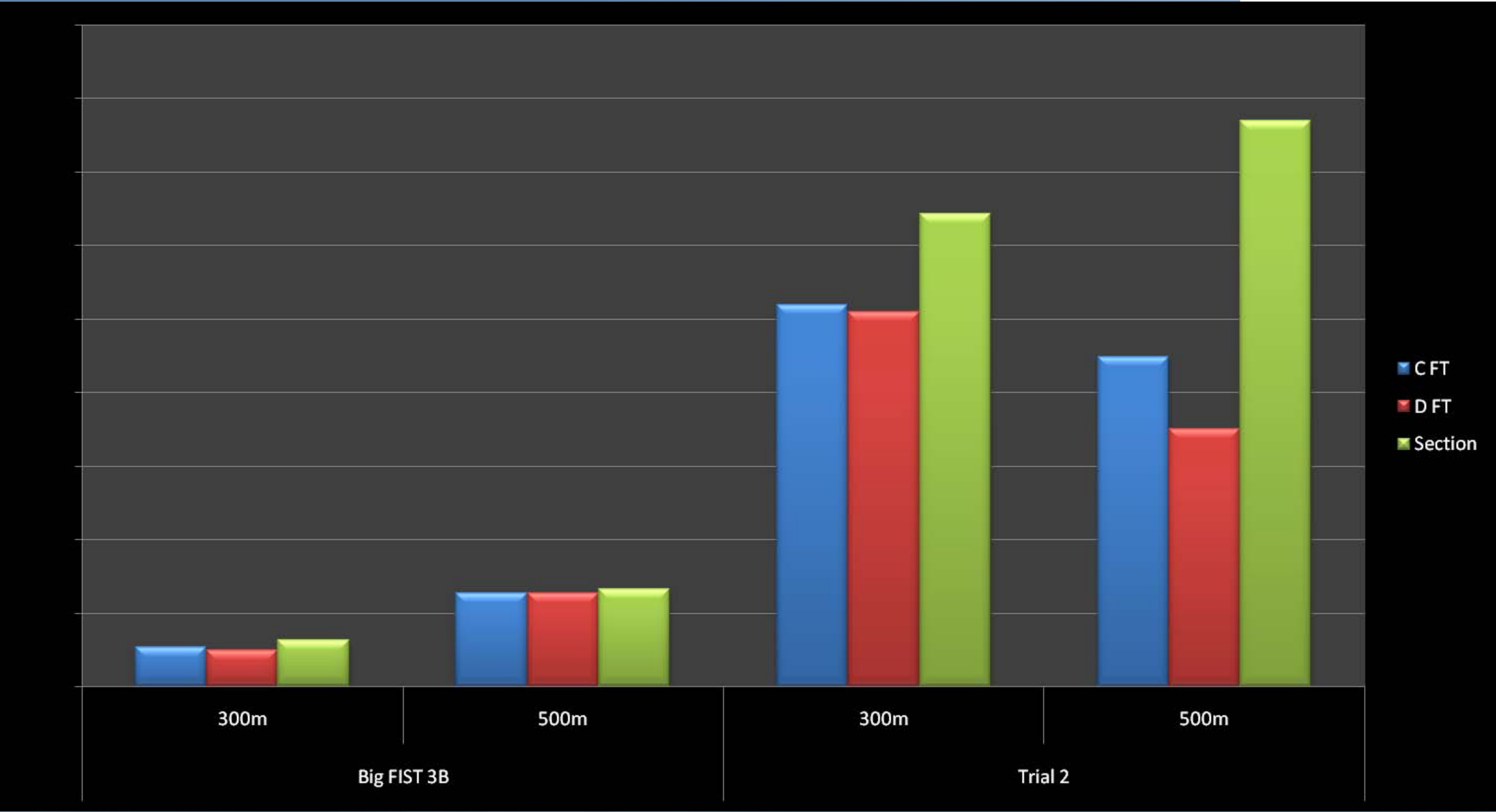
...Adding Value...

A Different Approach



...Adding Value...

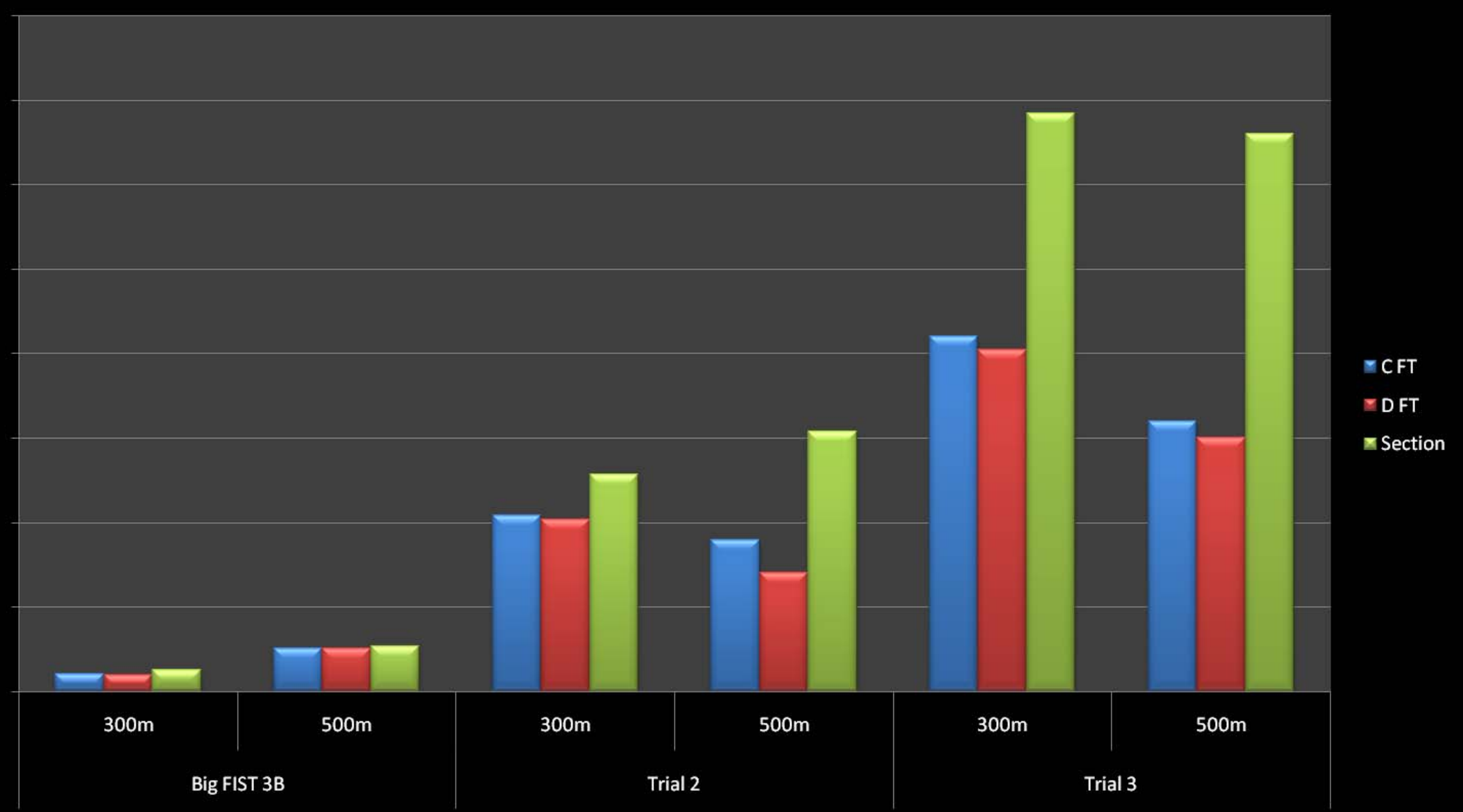
A Different Approach



...Adding Value...

A Different Approach

SDE



...Adding Value...

Conclusion

SDE

- FIT allows the effectiveness of live fire tactical training to be measured.
- FIT allows weaknesses in the delivery of lethal effect to be identified and improved.
- FIT assists with improved capability on the battlefield.

LIVE FIRE INTELLIGENT TARGETS

LFIT - The Future

SDE

- emonstration to School of Infantry Mar 08.
- n negotiation with School of Infantry to provide LFIT service to all recruit and command courses up to platoon leader.
- tarting discussions with RAF Regiment.
- iscussions with HQ Land Command to support Pre Deployment Training (PDT).

Suppressing Sacred Cows

Graham Evenden
Director – Business Development

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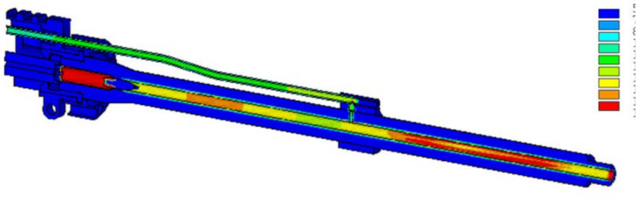
Direct Dial: +44 1373 827023
E-mail: Graham@SystemDesignEvaluation.co.uk
www.SystemDesignEvaluation.co.uk

Advanced Thermal Management of Automatic Rifles



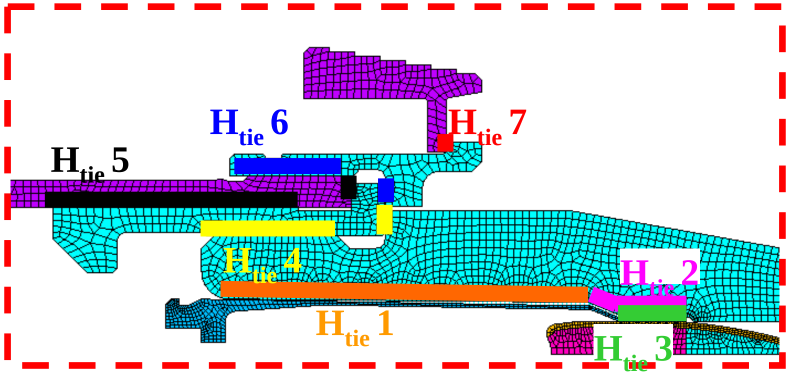
George Kontis
Knight's Armament Company

Laurie A. Florio, Ph.D.
US ARMY ARDEC

Previous Contract

Thermal Management for Automatic Firearms: 2007 Objectives

- Create a 2-D model to predict thermal characteristics of automatic weapon.
- Solve the cook-off problem in USMC IAR project



Current Contract

Tasks for Advanced Thermal Analysis:

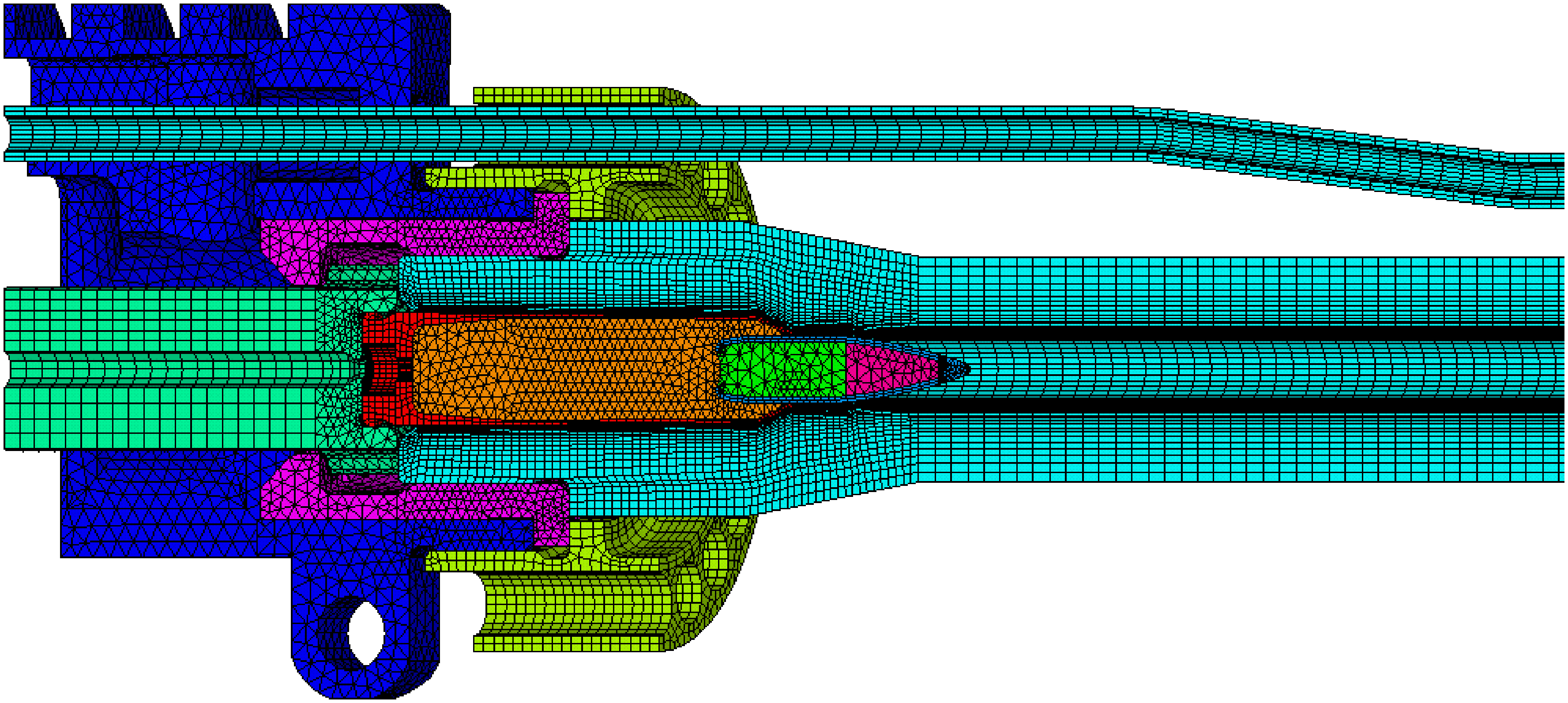
- Create a 3D model for improved accuracy and better connection to actual hardware
- Reduce the reliance on experimental data
  - Simulate the bore heat transfer during firing
  - Simulate the flow cooling the exterior of the weapon
- Determine the method for general use of these techniques
- Consider user needs:
  - How to apply advanced thermal management to improve both weapon function and usability.

Analysis Requirements

- Solid Model Geometry
- Boundary Conditions
  - Firing Schedule
  - Internal (Barrel Bore)
  - External
- Adequate Computing Resources
  - CFD model run time is measured in weeks
  - Thermal model run time is measured in days

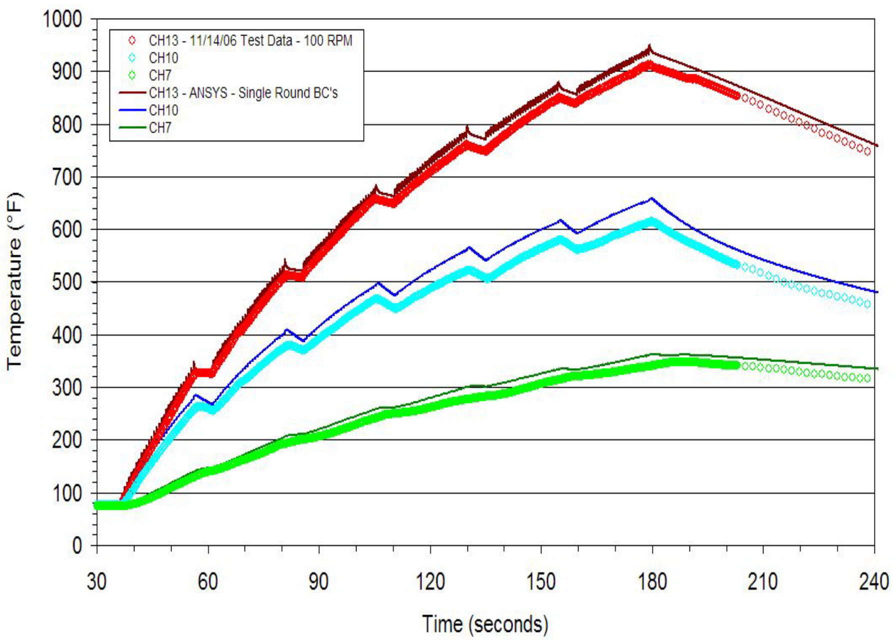
Solid Model to Analysis Model

- Solid model is meshed
  - Thousands of volumes used to solve the problem



Firing Schedule

- Firing schedule needs to be defined
  - Any firing rate can be specified
  - Any number of bullets
  - Any number of magazines



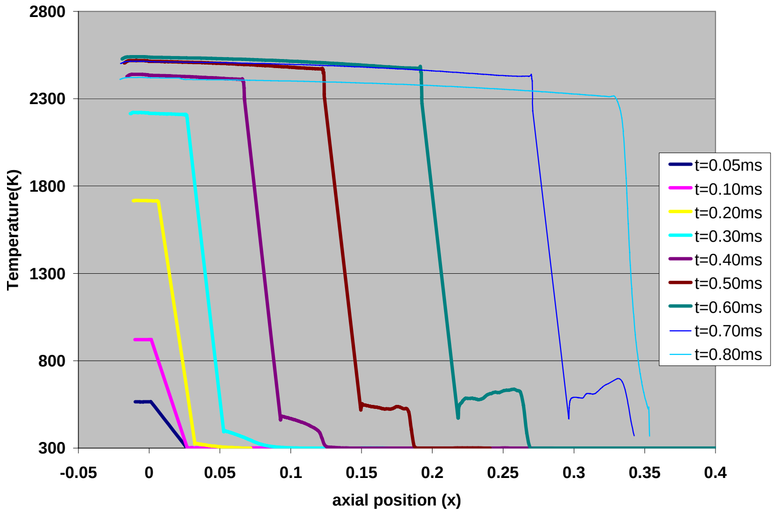
Test data vs Analytical--model by individual round

Bore Heat Transfer Simulation:

US. Army ARDEC CFD model:

- Simulate the bulk effects of combustion
- Transient solution captures the motion of bullet
- Cooling period after bullet firing is simulated
- Gas temperatures and heat transfer coefficients are input into the heat transfer model

Gas temp.



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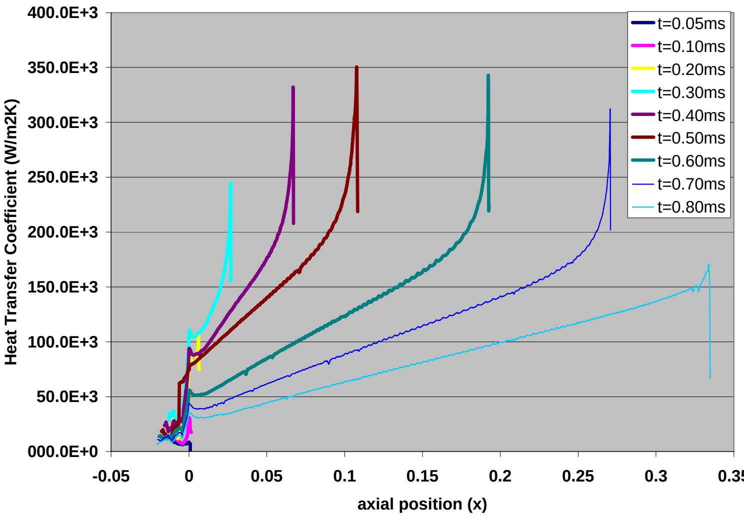
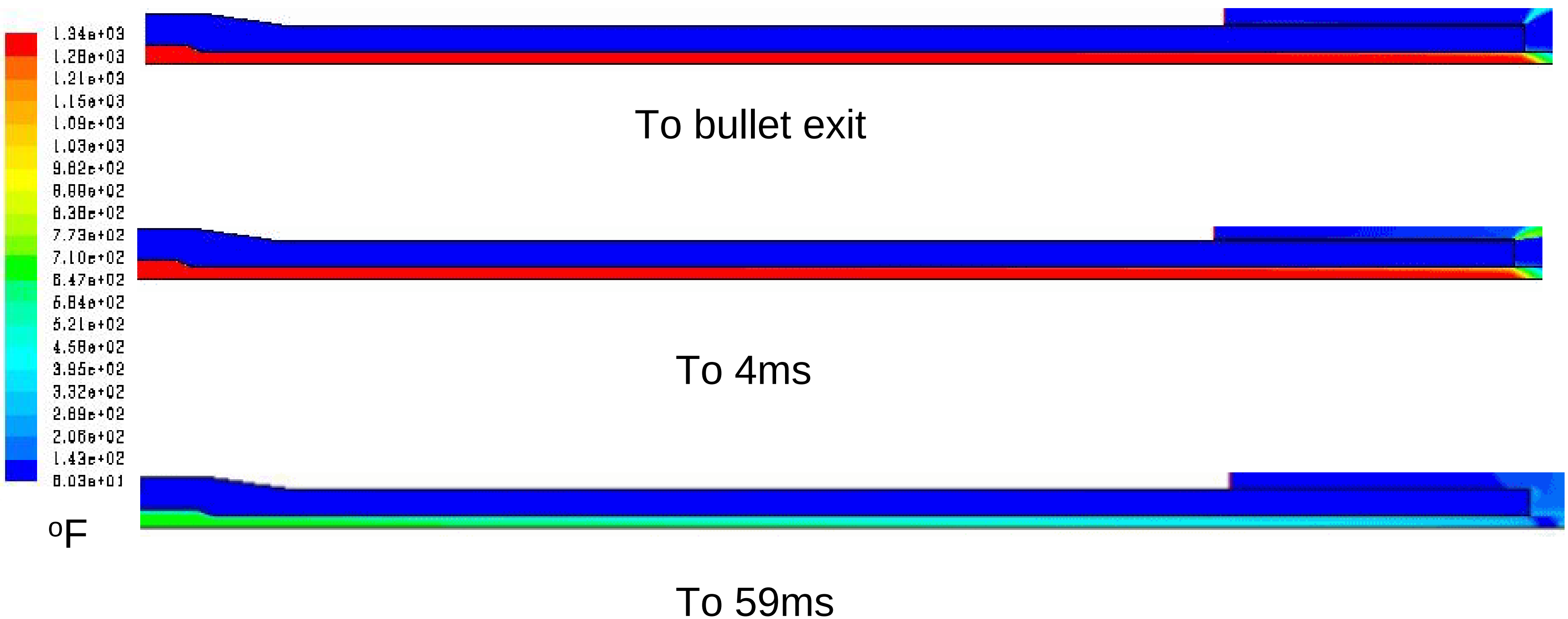


ARDEC Bore CFD Model

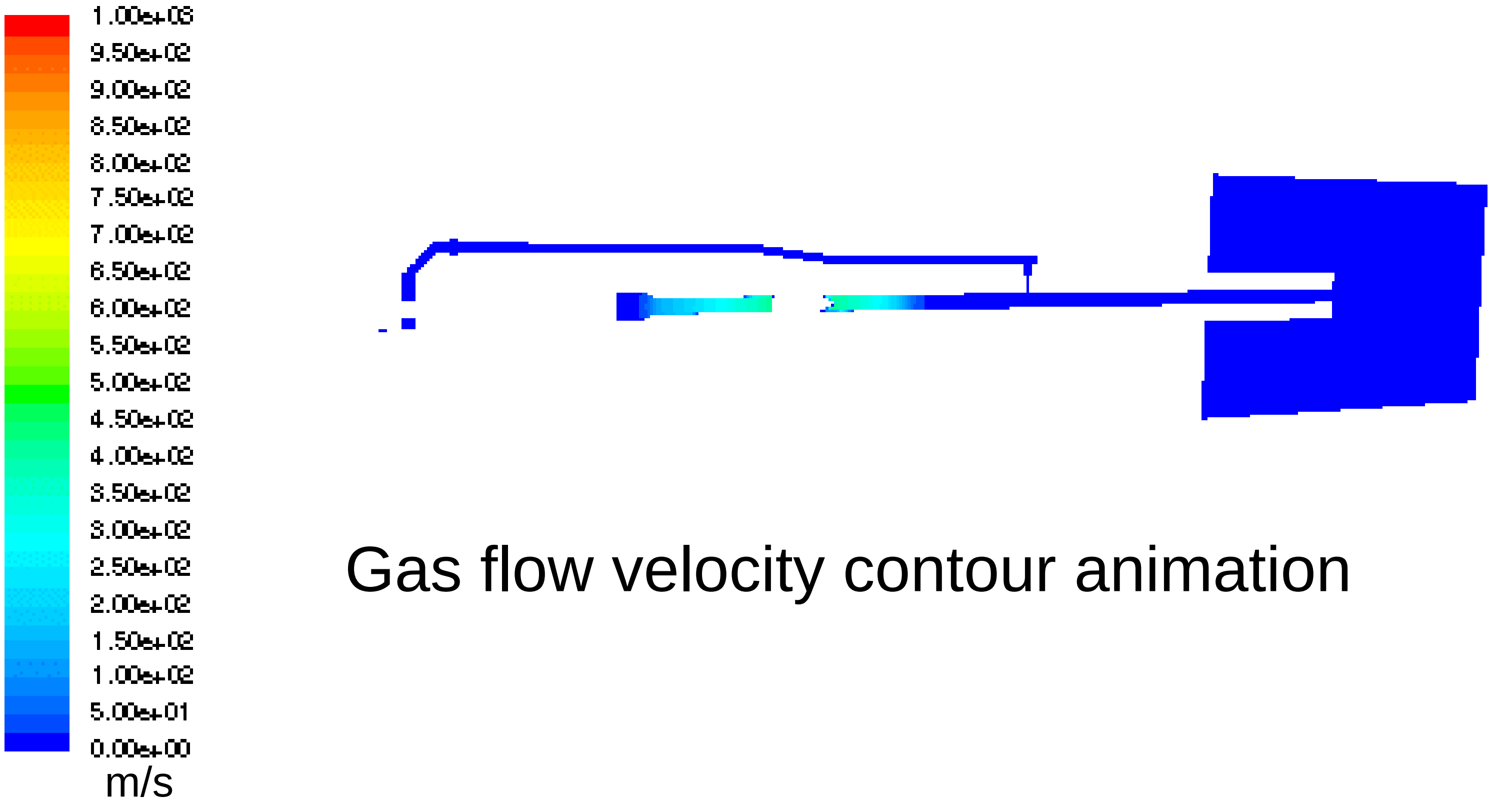
- Model used to calculate heat input to barrel



Temperature contour animations of firing one round

Boundary Condition Validation

- ARDEC CFD gas flow model used to estimate the flow rate, temperature, pressure of flow in gas tube to estimate heat transfer to gas tube

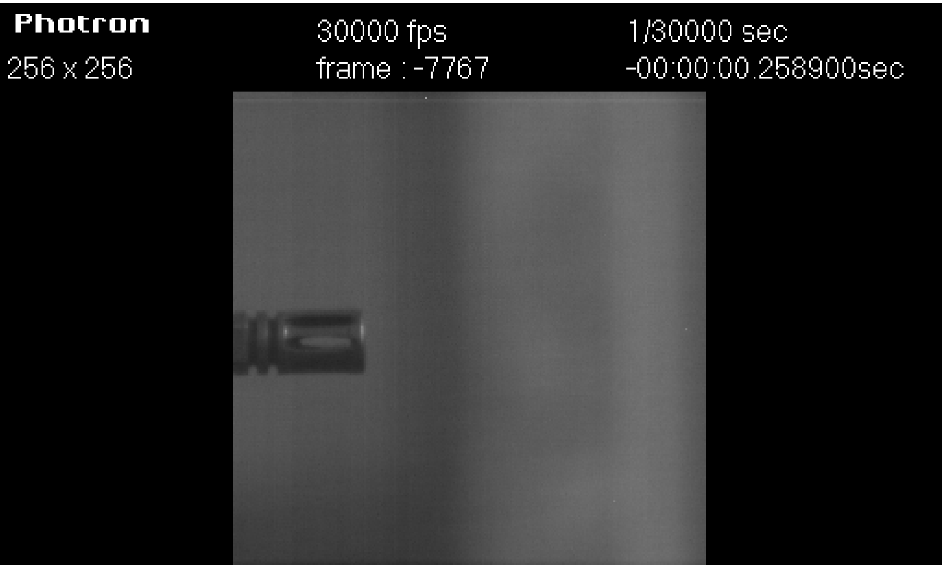


Gas flow velocity contour animation

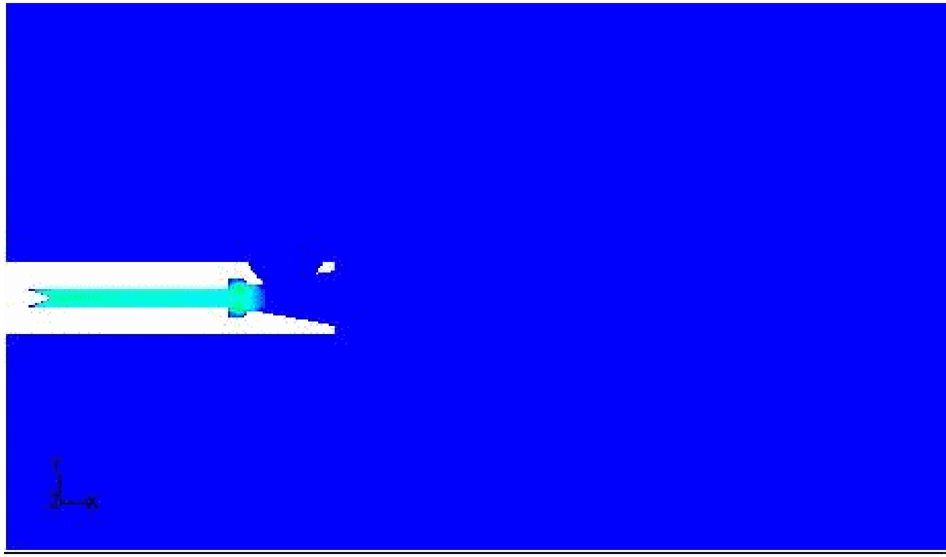
Boundary Condition Validation

- ARDEC Muzzle CFD model used to determine extent of effect of escaping gun gases on the external flow

High Speed Video

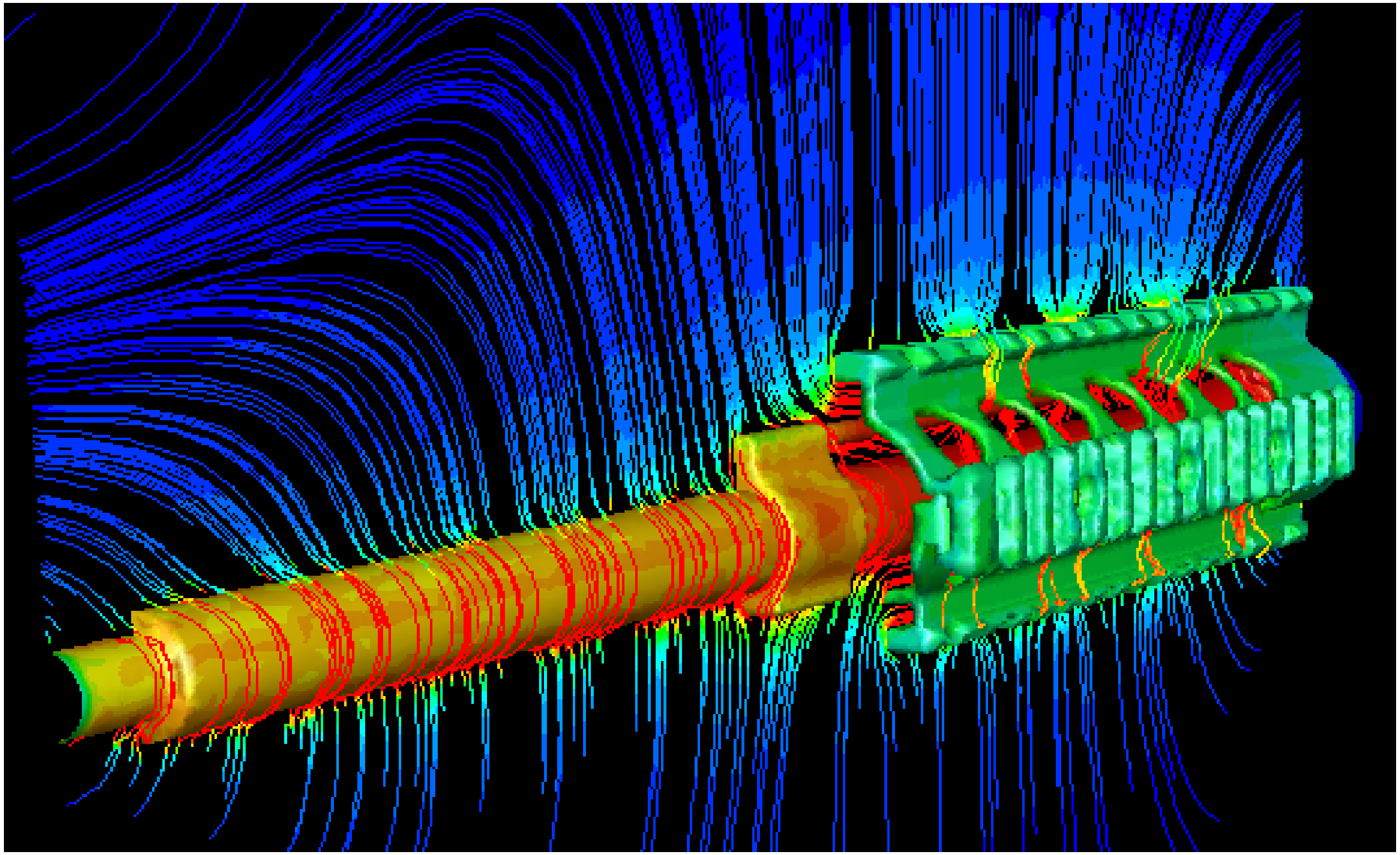


Velocity Contour Plot Animation

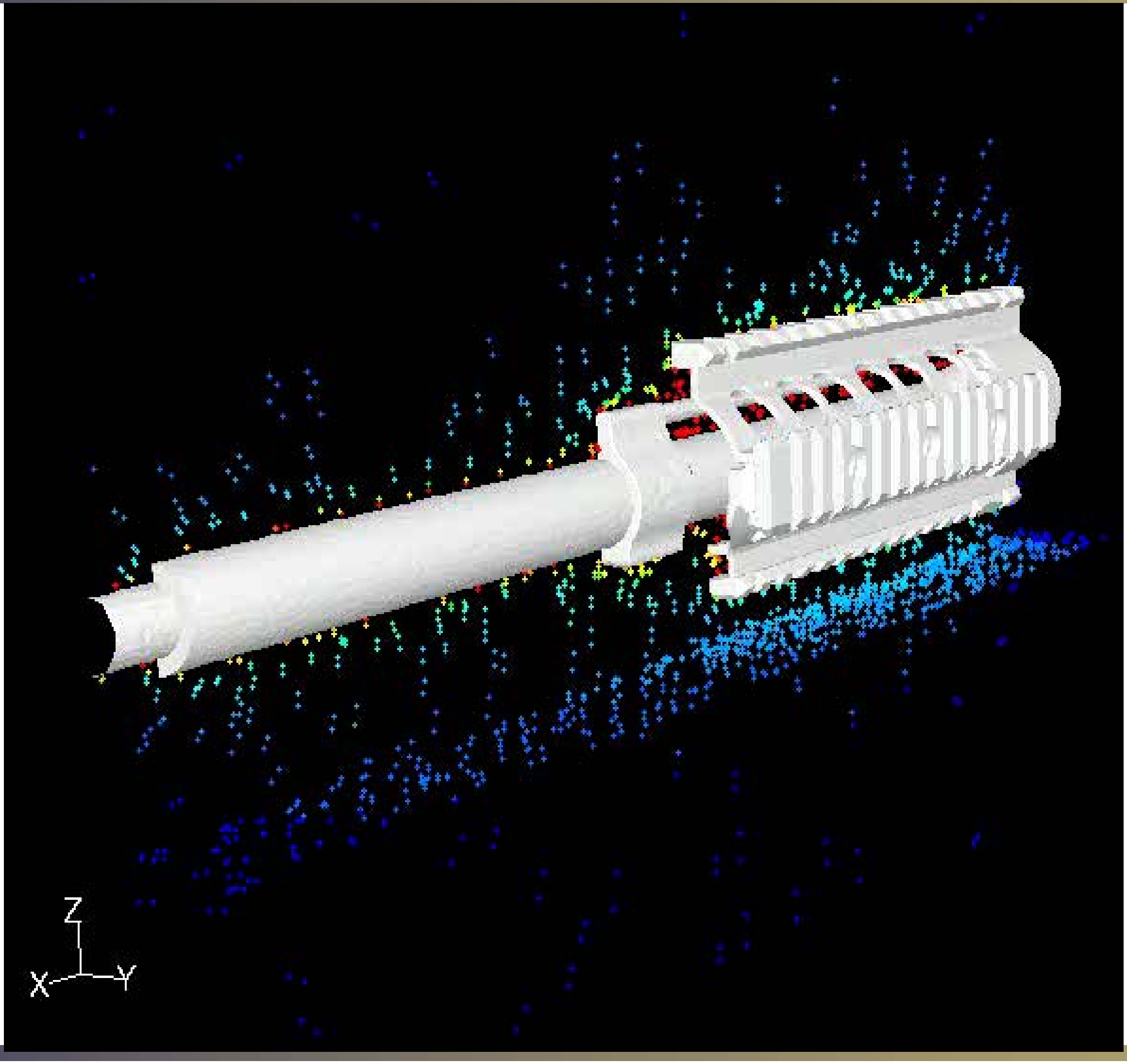


External Flow CFD Simulation

- Based on ARDEC Muzzle CFD model, muzzle blast can be ignored

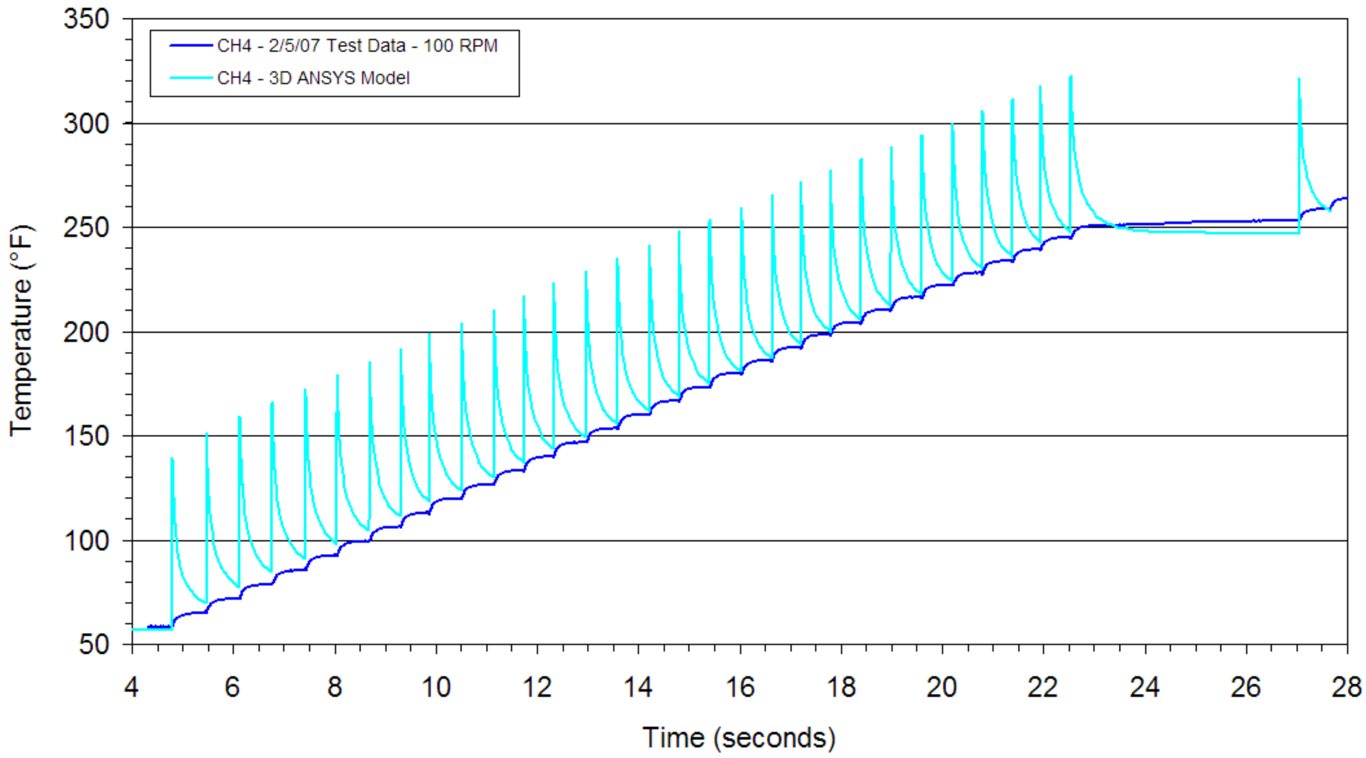


External Flow CFD Simulation



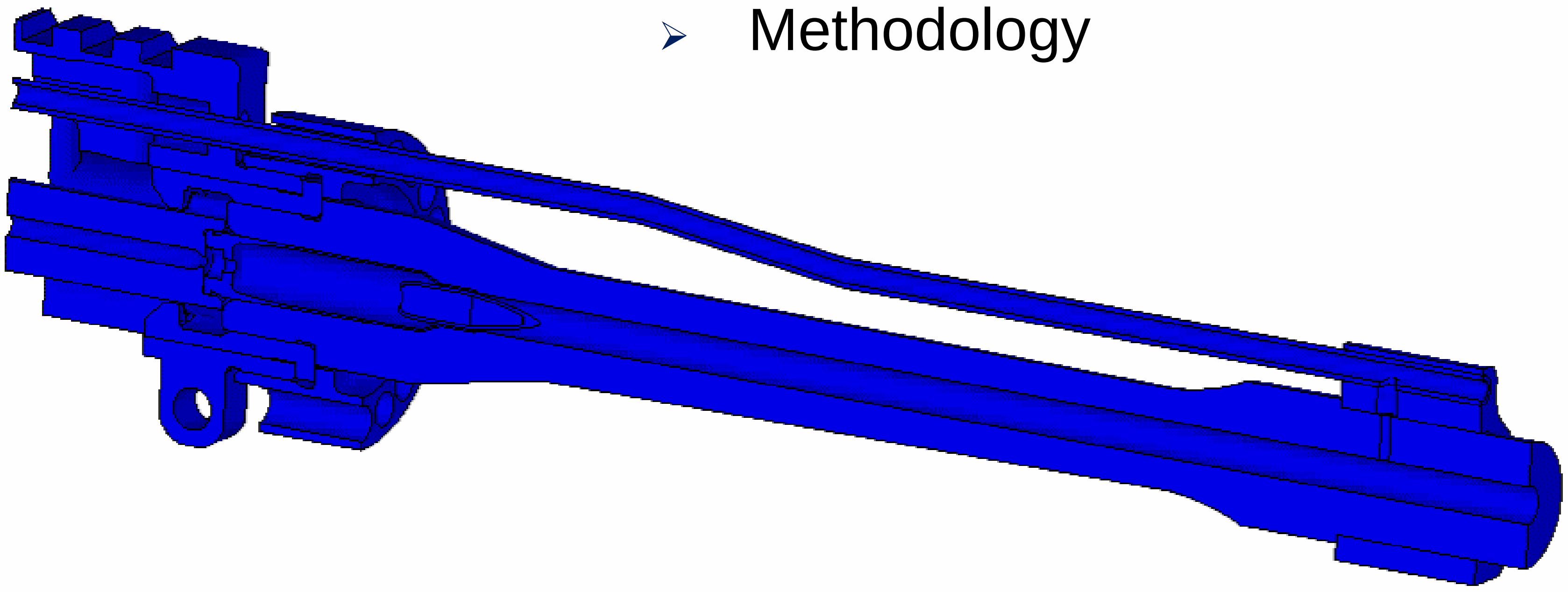
Current Thermal Model Results

- Model agrees with test data extremely well



Current Thermal Model Results

- Study completion in July 2008
  - 3D modeling
  - Methodology



SINGLE ROUND ANIMATION

Contact Information

- George Kontis

  Knight's Armament Company

  321-607-9900

  gkontis@knightarmco.com

- Laurie A. Florio, Ph.D.
  US Army ARDEC
  973-724-5993
  laurie.florio@us.army.mil

Joint Service Small Arms Synchronization Team (JSSAST) Update

for

Joint Services Small Arms Systems Section Annual Symposium, Exhibition and Firing Demonstration

20 May 2008

Presented
By

COL Scott Flynn
JSSAST Chairman

JSSAST Update

Agenda

- JSSAST Mission
- JSSAST Membership
- Overarching Themes and Status
- Current Programs and Future Plans
- What’s Next?

Members

Joint Service Small Arms Program Office (JSSAP)

- **Who**
  - **Joint Service Office Located Within US Army ARDEC**

- **Mission**
  - **Establish Joint Requirements**
  - **Evolve Technology for New Soldier Weapon Systems**
  - **Manage and Execute the Technology Base**

Members

Joint Service Small Arms Synchronization Team (JSSAST)

Meets Semiannually

Chairman

COL Scott Flynn (Director, ESIC)

Principals:

Army:	COL Robert Radcliffe (USAIC)
Marines:	LtCol Tracy Tafolla (HQ MCSC)
Air Force:	Col Charles Beck (HQ AFSFC)
Navy:	CAPT Patrick Sullivan (HQ NAVSEA)
Coast Guard:	CAPT Scott Genovese (HQ USCG)
SOCOM:	COL Kevin Noonan (HQ SOCOM)

Associates:

Army PMSW:	COL Carl Lipsit (PM Soldier Weapons)
JNLWD:	Mr. Kevin Swenson (JNLWD)

JSSAST Themes

FY08-10

JSSAP Awareness Campaign:
✓-Continue meeting with Service Members and HQ's
- Extend to the Office of the Secretary of Defense

Joint Service Small Arms Master Plan (JSSAMP)
✓ - Complete Departmental approvals of current document
- Update JSSAMP in FY09/Approve in FY10

Lightweight Small Arms Technologies (LSAT)
✓- Establishment of a Joint Requirement
- Build a jointly funded program for the SDD and Production Phases of Acquisition

Joint Small Arms Capabilities Assessment (JSACA)
- Update current document in FY09
- Harmonize the results of the various on-going Service capabilities assessments

Awareness Campaign Status

Completed

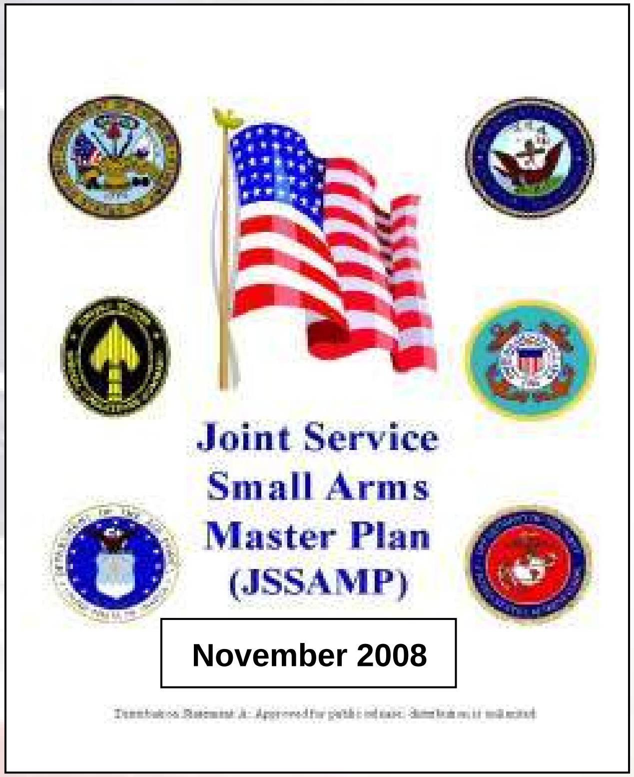
- US SOCOM PEO SOF Warrior
- USMC PM Infantry Weapons
- USCG Deputy Assistant Commandant for Capabilities
- USN PEO Littoral and Maritime Warfare
- JNLWD Acquisition Division Chief

Planned

- USAIC Director Combat Developments
- US Army TRADOC
- All Service Higher HQ Elements
- Office of the Secretary of Defense

JSSAMP Status

Revise/Approve FY09-10



JSSAMP Approved by All Service HQ Elements

Lightweight Small Arms Technologies

Current Technology Objectives:
- 35% Reduction in Weapon Weight
- 40% Reduction in Ammunition Weight
- Maintain or Improve Performance
- Demonstrate in Light Machine Gun

Many GO Live Fire Demos Conducted

Payoff:
- Increased Mobility and Maneuverability
- Decreased Logistics Burden
- Reduced Training and Maintenance

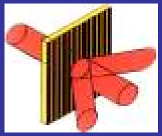
Lightweight Machine Gun Concept

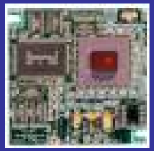
Transition and Fielding:
- Transition Strategy Planning Initiated
- Joint Capabilities Tech Demo Being Explored

Risk Level:
- Medium

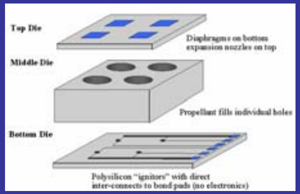
	M249	Goal	Caseless/CTA
Weapon	17.5 lb	11.4 lb	9.9/9.8 lb
Ammo (600 Rds)	20.4 lb	12.2 lb	10.0/13.6 lb
System (Wpn +Ammo)	37.9 lb	23.6 lb	19.9/23.4 lb

JSSAP Technology Objectives





Advanced Fire Control Technology



Advanced Lethal Armament Technology

Both Efforts Initiated in FY 08

Long Term Technology Strategy

Futures Conferences

Futures I

Who: Principally Science Fiction Writers
When: 11-12 March 2008
What: Broad-based Concepts Identified and Assessed

Futures II

Who: SME's from Military, Industry, Academia, Government and National Labs
When: 30 April-1 May 2008
What: Technologies Mapped to Concepts and Assessed

Concepts Assessed wrt Empowerment of Small Arms Platforms

- Lethality/Incapacitation
- Network Integration
- Overall Integration

What's Next?

- Continue Operational Awareness Campaign
- Develop Transition Strategy for LSAT Technologies
- Execute Fire Control and Lethality Technology Thrusts
- Initiate JSACA Update
- Develop Long Term Technology Strategy

ARMAMENT RESEARCH, DEVELOPMENT & ENGINEERING CENTER
PICATINNY, NJ

J·S·S·A·P
JOINT SERVICE SMALL ARMS PROGRAM

Assistant Commandant for Capabilities

Joint Service Small Arms Systems Annual Symposium

20 May 2008

CAPT S. D. Genovese
Commandant (CG-7D)
Coast Guard Headquarters

Overview

- Handgun Replacement Project
- Near Term Re-Cap Goals
- Near Term Projects
- Top Map

Handgun Replacement Project

- **SIGARMS P229R-DAK is Replacing the M9 Beretta.**
  - Approximately 85% of the Coast Guard has transitioned.
- **Type classification – NSWC Crane Division.**
  - .40 caliber (frangible, JHP, & Ball).
  - Frangible contract being reworked.
  - 5 year Indefinite Delivery/Indefinite Quantity (IDIQ) contract with FEDERAL for JHP & Ball (both 155 grain).
  - Hazard Class assigned (1.4S).
  - Final NALC/NIIN assigned.
  - WSESRB Pends.

Near Term Re-cap Goals

Over the next two years the Coast Guard is going to finish re-capitalization of its handgun, machine gun, and disabling fire weapon inventories. This effort will include the replacement of the:

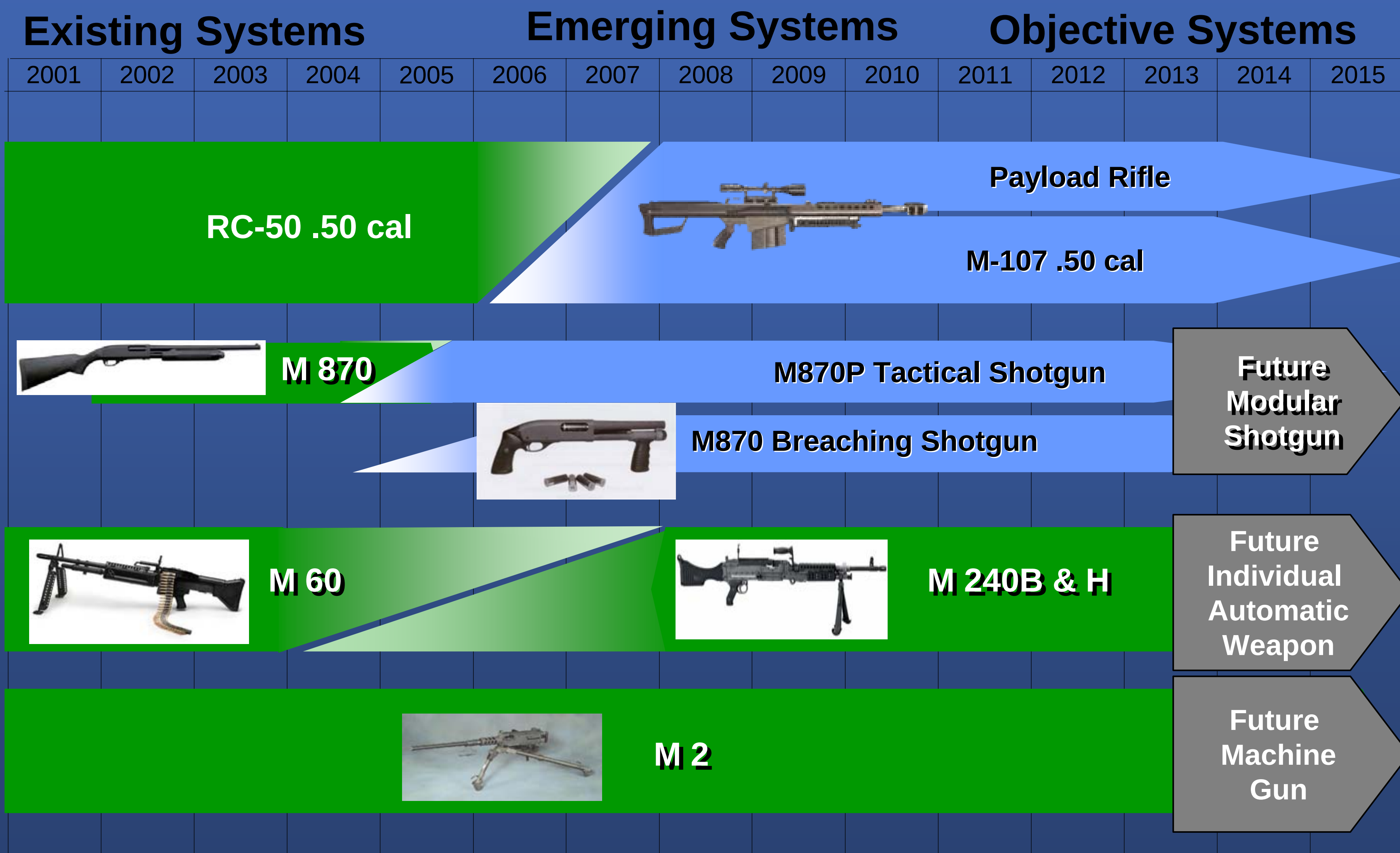
- M9 pistol with the SIGARMS P229R-DAK pistol.
- M60 machine gun with the M240B/H.
- Robar RC-50 .50 caliber rifle with the M107.

Near Term Projects

- The Coast Guard will continue to refine policy and the supporting Tactics, Techniques, and Procedures for two (02) new weapons initiatives in the inventory:
  - MK11 rifle. The MK11 will be used for precision engagement.
  - M14T rifle. The M14T will be used in support of Airborne Use of Force.
- Currently, there are no near term plans to change the standard service rifle/carbine (M16, M4, MK18), the service shotgun (M870P), or the venerable M2HB machine gun.

CG Small Arms Top Map

CG Small Arms Top Map



Questions?

Location & Organization

- Location.

  Commandant (CG-7D Small Arms)
  Coast Guard Headquarters
  2100 2nd Street SW, Room 3406
  Washington, DC 20593

  Phone: (202) 372-2030

- Organization.
  - Office of Specialized Capabilities.
    - Member of the Joint Service Small Arms Synchronization Team (JSSAST).
  - Organization Staffing.
    - Captain Scott Genovese (Deputy Assistant Commandant for Capabilities).
    - LT Sean Cashell (Small Arms Program Manager).
    - Chief Warrant Officer John McDaniel (Assistant Small Arms Program Manager).
  - Liaison Positions.
    - Small Arms Repair Facility at NSWC Crane, Indiana.
    - Liaison to the Naval Operational Logistics Support Center (NOLSC) Mechanicsburg, Pennsylvania.

JSSAP

Future Small Arms Technology Plan Development

The Fusion of Science and Science Fiction

Joel M. Goldman

Chief, JSSAP Office

JSSAP's Future Small Arms Technology Plan
The Fusion of Science and Science Fiction

Briefing Outline

Purpose
Futures I: The Science Fiction Writers
Futures II: The Scientists, Engineers and Military
Follow-on Activities: Plan Development

Purpose

Develop the Foundations
of a
Mid-Far Term Technology Investment Strategy
for
The Joint Service Small Arms Program

Futures I
The Science Fiction Concepts

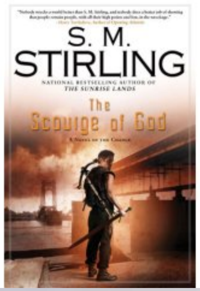
Who: Principally Science Fiction Writers

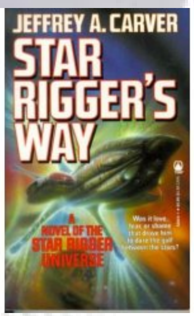
When: 11-12 March 2008

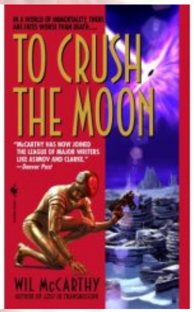
What: Broad-based Concepts Identified and Assessed
- Positives
- Negatives
- Enhancements
- Potential

The Generation of Concepts That Will Lead to Creation of a Warfighter Capable of Overwhelmingly Defeating the Enemy Combatant of the Future

Futures I
The Science Fiction Concepts







The Science Fiction Writers

Charles Gannon

S. M. Stirling

Will McCarthy

Kathleen Goonan

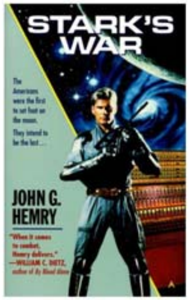
Jeffery Carver

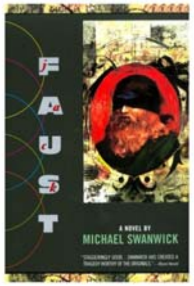
Arlan Andrews

Matt Armstrong

John Hemry

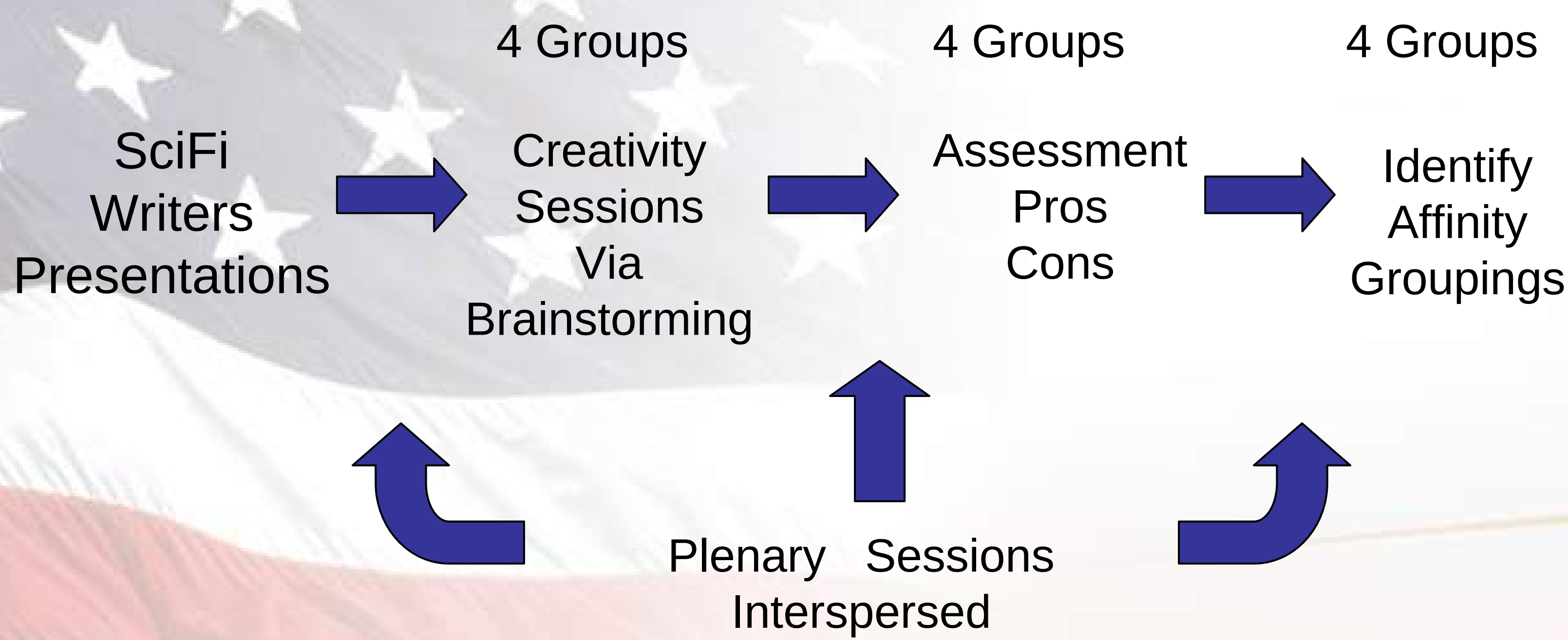
Michael Swanwick





Futures I
The Science Fiction Concepts

The Process



The Generation of Concepts That Will Lead to Creation of a Warfighter Capable of Overwhelmingly Defeating the Enemy Combatant of the Future

Sampling of Concepts

Robotic Dog (“Snoopy”)

Persian Donkey

G-D-H (Girlfriend – Dog – Hawk)

Understand Motivation of Enemy

Smart Dog Tag

Psychic Potential

Personal Strap-on Jets

Odors   Sheddable Exoskeleton

Artificial Muscles   Brain Plasticity   Zero Point Energy   Antimatter

Prosthetics as Fighting Aids   Panic Generator   Explosive Suppressor

Kamikaze UAV Bombers   Climate Change   Nutraceuticals

Stealth via No Emissions   Holographic Deception   “Mouse”/Camera

Futures I
The Science Fiction Concepts

Affinity Groupings

Intelligence Gathering – 10 Concepts

Human Factors – 18 Concepts

Increased Firepower – 18 Concepts

Increased Survivability – 5 Concepts

Increased Battlefield Impact – 23 Concepts

Futures I
Example Concepts

Intelligence Gathering

Understand motivation of enemy
MOUT/counter-insurgent operations where an enemy is not in uniform.
Pros: Interpret actions as being friendly/hostile.
Predictability,
Diffuse confrontations,
Empowering the warfighter
Cons: Requires training,
Leaves the decision in warfighters hands

Human Factors

Artificial muscles
For large muscle control and fine muscle control.
May enable microsurgery on the battlefield
Pros: Provides superhuman strength, reduces fatigue
Cons: Unintended consequences

Increased Survivability

Odors
Demographic/friendly force specific products
Pros: Differentiates, allows IFF
Cons: One aspect of info (not 100% reliable)
May be easy to spoof if the predominate odors are due to cosmetics or laundry.

Increased Battlefield Impact

Nanoparticle dust information gathering
Projectile-based dispersal of small "dust sized" information gathering particles.
Pros: Remote, versatile
Lower interception/jamming potential
Con: Environmental issues (wind, fans, etc)

Enhanced Firepower

Zero Point Energy
Tapping energy from the quantum vacuum.
Nanotech batteries may use this technology.
Pros: Inexpensive, freely available energy
Cons: No technology to harvest or utilize

Futures II
The Scientists, Engineers and Military

Who: SME's from Military, Industry, Academia, Government and National Labs
When: 30 April-1 May 2008
What: Technologies Mapped to Concepts and Assessed
Concepts Assessed wrt Empowerment of Small Arms Platforms
- Lethality/Incapacitation
- Network Integration
- Overall Integration

Identify the Concepts That Can Empower the Warfighter's Small Arms Platform

Futures II
The Scientists, Engineers and Military

Process

Affinity Groupings

Intelligence Gathering
Human Factors
Enhanced Firepower
Increased Battlefield Impact

→

4 Groups

Generate
Additional Concepts;
&
Link Technologies

→

4 Groups

Assessment
Mid to Long Term
Rationale

↓

4 Groups

Assess
Linkage to
Small Arms
Platforms

←

4 Groups

Assessment
Network
Incapacitation
Overall Integration

←

Prepare Report
&
Develop Plan

Human Factors Example Output
Part I

Augment the Warfighter Mobility Via Sheddable Exoskeleton

Concept	Technology	Short Term Feasibility	Long Term Feasibility	Assessment with Support Rationale

Augment the war fighter mobility by a sheddable exoskeleton	Biomechanics	H	H	• Greater Load – Short Term/ Medium
				• Greater warfighter agility – Long Term/Low
				    • Lack of acceptance from user
				    • Biomechanical limitations of body
				• Scalable complexity

Feasibility Ranking Legend: U = Undetermined, L = Low feasibility, M = Medium feasibility, H = High feasibility
Assessment to include challenges to implementation and concept/technology maturity

Human Factors Example Output
Part II

Augment the Warfighter Mobility Via Sheddable Exoskeleton

Concept or Technology	Platform	Application or Linkage to Small Arms	Network Centric Integration	Improved Lethality or Incapacitation	Integration of Network centric & Lethality or Incapacitation	Assessment with Support Rationale
Biomechanics Actuators/power DARPA SARCOS ONR Lightweight materials Sensor	All platforms	Y	N/A	Y	N/A	• Leverage shock mitigation work in shipping sensitive materials • Weight and power concerns • Maturity Level •Short Term – Medium (load carriage) •Long Term – High (agility) • Recommendation - Continue funding •Customized applications •Watch link to prosthetics •Partial exoskeleton

Application/Linkage Ranking Legend: Y = Yes, N = No
Network Centric Integration Ranking Legend: U = Undetermined Risk, L = Low Risk, M = Medium Risk, H = High Risk
Improved Lethality/Incapacitation Legend: U = Undetermined, Y =Yes, N = No
Integration of Network Centric & Lethality/Incapacitation Legend: U = Undetermined Risk, L = Low Risk, M = Medium Risk, H = High Risk

What's Next?

Complete the Future Tech Assessment Report
Brief at National Small Arms Center Meeting
Solicit White Papers Submissions
Develop the Technology Plan

Forge a Technology Investment Strategy That Will Lead to Small Arms Systems Capable of Overwhelmingly Defeating the Any Enemy Combatant of the Future


ARMAMENT RESEARCH, DEVELOPMENT & ENGINEERING CENTER
PICATINNY, NJ
J·S·S·A·P
JOINT SERVICE SMALL ARMS PROGRAM


DEPARTMENT OF THE ARMY
UNITED STATES OF AMERICA
1775
DEPARTMENT OF THE AIR FORCE
UNITED STATES OF AMERICA
1790

Project Manager
Maneuver Ammunition Systems

"Enhancing Small Arms Effectiveness in Current and Future Operations"

Chris Grassano
Project Manager

22 May 2008

Top 10 Military Instructions

10 - **"AIM TOWARDS THE ENEMY."** -Instruction printed on US Rocket Launcher

9 - **"WHEN THE PIN IS PULLED, MR. GRENADE IS NOT OUR FRIEND."** -US Marine Corps

8 - **"CLUSTER BOMBING FROM B-52s IS VERY, VERY ACCURATE. THE BOMBS ARE GUARANTEED TO ALWAYS HIT THE GROUND."** -U.S.A.F. Ammo Troop.

7 - **"IF THE ENEMY IS IN RANGE, SO ARE YOU."** -Infantry Journal

6 - **"A SLIPPING GEAR COULD LET YOUR M203 GRENADE LAUNCHER FIRE WHEN YOU LEAST EXPECT IT. THAT WOULD MAKE YOU QUITE UNPOPULAR IN WHAT'S LEFT OF YOUR UNIT."** -Army's magazine of prevention maintenance

5 - **"TRY TO LOOK UNIMPORTANT; THE ENEMY MAY BE LOW ON AMMO."** -Infantry Journal

4 - **"TRACERS WORK BOTH WAYS."** -U.S. Army Ordnance

3 - **"ANY SHIP CAN BE A MINESWEEPER....ONCE."** -Anonymous

2 - **"DON'T DRAW FIRE; IT IRRITATES THE PEOPLE AROUND YOU."** -Infantry Journal

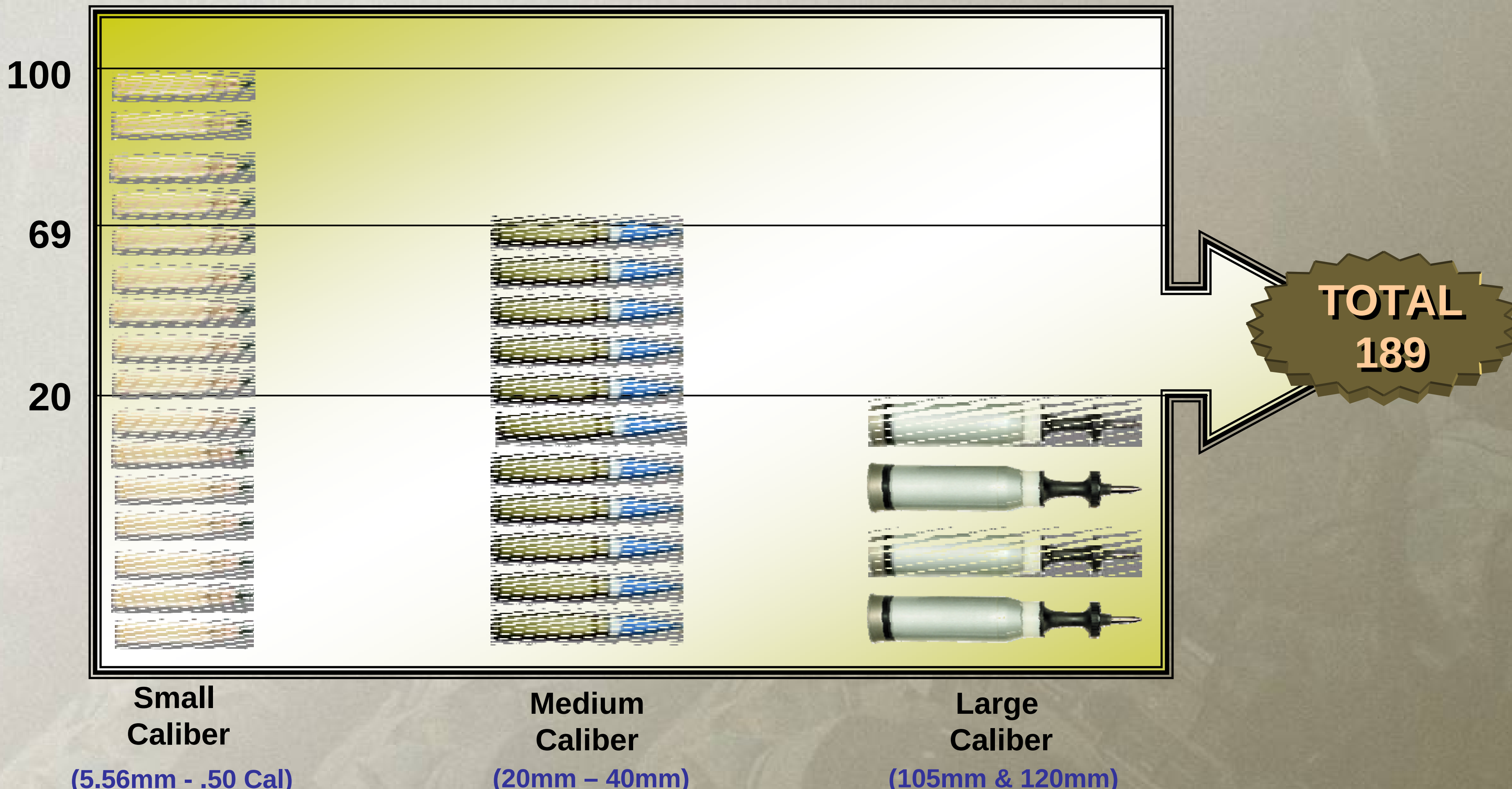
1 - **"IF YOU SEE A BOMB TECHNICIAN RUNNING, TRY TO KEEP UP WITH HIM."**
-U.S.A.F. Ammo Troop

Project Manager
Maneuver Ammunition Systems (MAS)-Direct Fire

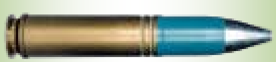
MISSION: PM MAS Provides Direct Fire Combat And Training Ammunition Capabilities To All Warfighters (Army, Navy, Air Force, Marines)

DISTRIBUTION STATEMENT A:

Ammunition Products



PM MAS
FY08 Procurement Quantities
(What we are Ordering)

		2008
Small Caliber (1,708M) 	5.56MM	1294.5M
	7.62MM	240.3M
	.50 Cal	94.7M
	9MM	62.6M
	Shot Shells, Calibers .45, .22, 30	16.2M
Medium and Medium Cannon Caliber (27.5M) 	20MM	4.6M
	25MM	2.2M
	30MM	5.9M
	40MM	14.8M
Large Caliber (207K) 	105MM	.012M
	120MM TRAINING	.178M
	120MM TACTICAL	.017M

NOTE: All Services FY08 and Projected Supplemental

1.736B ctgs / $1.436B for FY08

DISTRIBUTION STATEMENT A:

PM-MAS 08 GOALS

- **Support Warfighters (GWOT)**
  - Production / Fielding
  - Logistics
  - Training
- **High Performing, Agile & Ethical Workforce**
  - **Grow People & Teams**
    - Training
    - Skills
  - Effective Management
    - System & Family Approach
    - Integrated Acquisition Lifecycle
    - War Reserve Management
- **Enhance Organic/Commercial Strategic Capabilities**
  - Shape Industrial Base Capacities to Meet Requirements
  - Modernize & Maintain Future Viability
  - Identify/Establish Alternate Sources
- **Develop & Field Capability Improvements**
  - Large Cal Strategy
  - Airburst fuzing
  - Small Cal RDT&E
  - FCS Support
  - Lethality

Small and Medium Caliber

- **Support Warfighter**
  - Meet Scheduled Production Goals
  - Reduce Delivery Backlogs
  - 40mm Baselining
- **High Performing Workforce**
  - Developmental Assignments
  - Training / Certifications
- **Enhance Strategic Capabilities**
  - Lake City Modernization Program
  - Develop Future Small Caliber and 40mm Strategies
- **Field Capability Improvements**
  - Green Ammunition
  - 40mm Pivoting Coupling
  - Small Caliber Case Mouth Waterproofing
  - Downselect 40mm High Velocity Non-dud-producing Training Round Configuration

Recent Past

- In All Direct Fire Ammunition Families; Continuing to Deliver at Highest Levels Since Vietnam War

- Capacities and Sources Have Increased
  - LCAAP - 1.2B (FY05) to 1.6B (FY07)
  - Second Source Small Caliber - 300M
  - New 40mm LAP Contractors

- New Capabilities Have Been Fielded
  - GREM
  - 12 Gauge Breeching
  - 7.62mm SRTA
  - 5.56m / 9mm SESAMs part of CCMCK (pending)
  - 40mm M992 IR Illum (pending)

Much for Government and Industry to be Proud

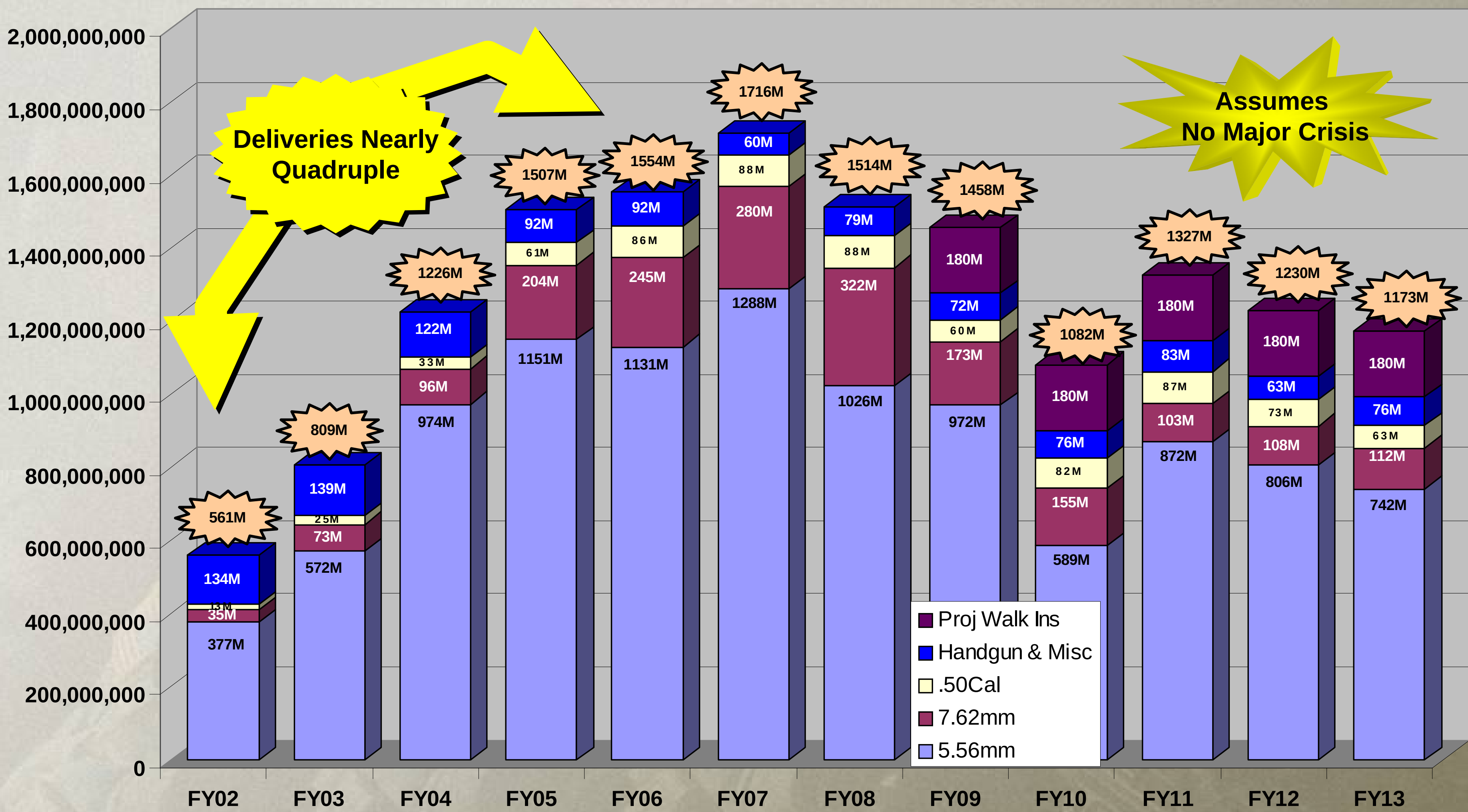
DISTRIBUTION STATEMENT A:

Small Caliber Acquisition Strategy

DISTRIBUTION STATEMENT A:

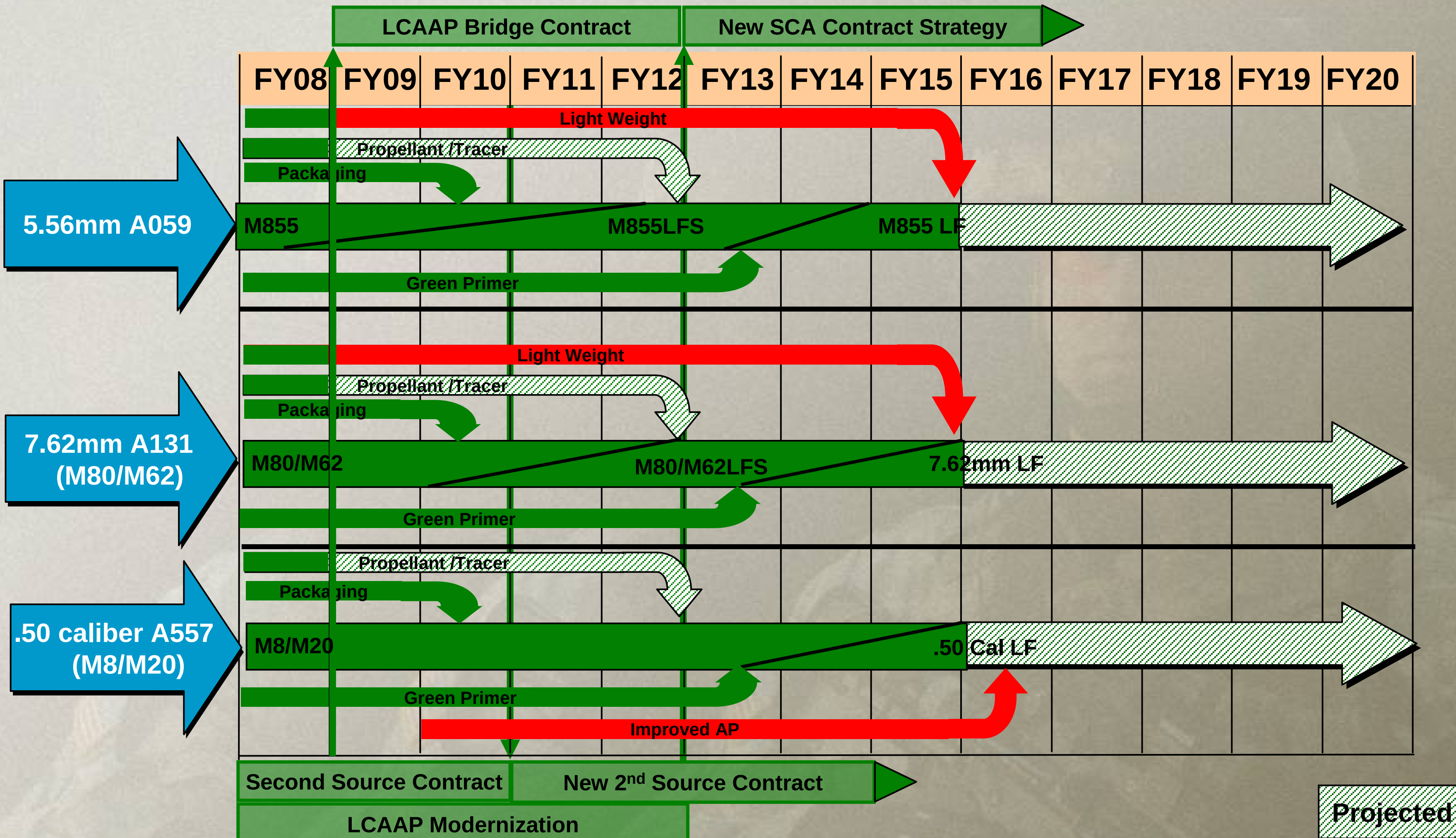
Small Caliber Ammunition Deliveries

(All Services)



DISTRIBUTION STATEMENT A:

Small Caliber Roadmap



- Sustains Training Ammo Support
- Meets Existing Tactical Requirements and Builds Tactical Stockpile
- Implements Green Program

Projected

Funded

Unfunded

Small Caliber NRE Efforts

- **Lake City AAP Modernization – Positions This National Asset for Future Use**
  - **7.62mm BAM Upgrade Depicted**

Before

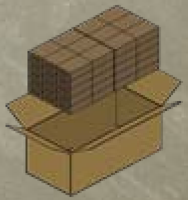
After

- **Case Mouth Waterproofing - Qualify Alternative Case Mouth Waterproofing Sealant Materials/Process to Increase Throughput by Reduction in "Leakers"**
  - **Reduce Failure Rate From 7% to 2 %**

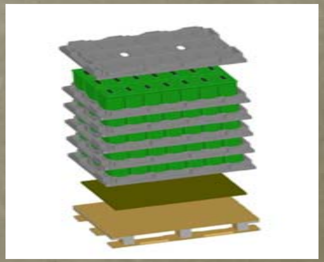
Sealant Applied

- **Packaging - Develop More Cost-Effective, High-performance Commercial Package for 5.56mm CONUS Range-fired Ammunition**
  - **Wirebound Elimination - $ 6M / yr savings**
  - **Simplified Bandoleer - $ 5M / yr Savings**

Commercial Pack

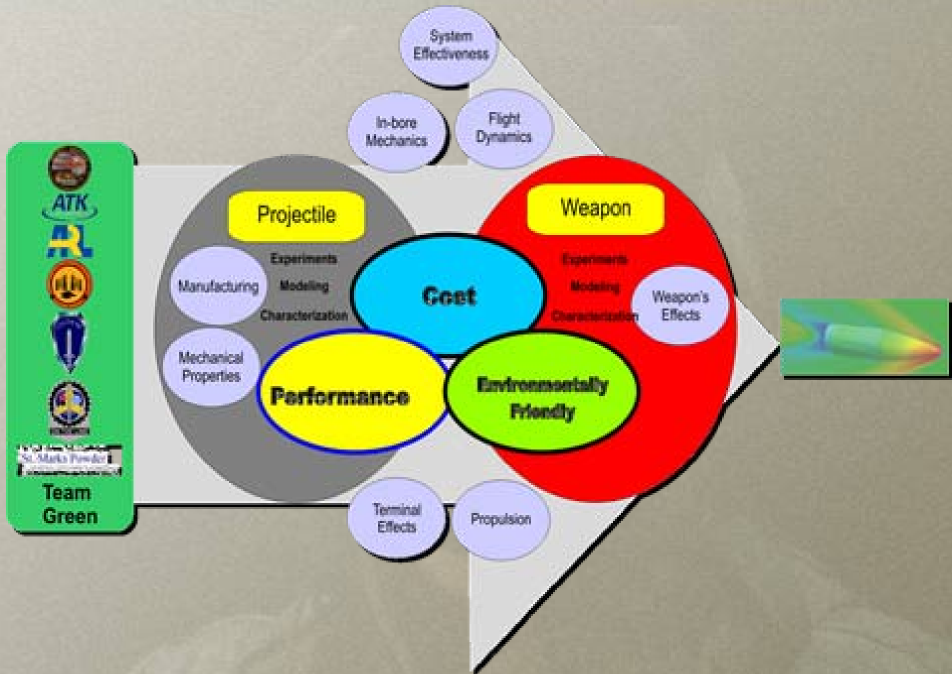


Wirebound Elimination



M855 LFS Green Ammunition

- **Field an Environmentally Friendly 5.56mm Cartridge That Will Exhibit Comparable Performance to Current Leaded M855**
  - Operational in M4, M16 and M249 Weapon Systems
  - Round Utilizes Latest Science and Technology to Improve Upon all Aspects of Round (Environmental Compliance, Accuracy)
  - Ballistically Matched to Army's Current Ball Round so There will be Minimal Training Impact
  - M855LFS will Begin Production Late FY08



40MM Grenade Family of Munitions

Current Acquisition Strategy

- Systems Contract Strategy
  - 2 Joint Venture Small Business Teams
- Government Focusing on Products/ Industrial Base, Not Parts

Mk 19
Grenade Launcher
(High Velocity 40MM)

M203
Grenade Launcher
(Low Velocity 40MM)

Examples of High and Low Velocity 40MM Grenades

M918 M430A1 M781 M433

High Low

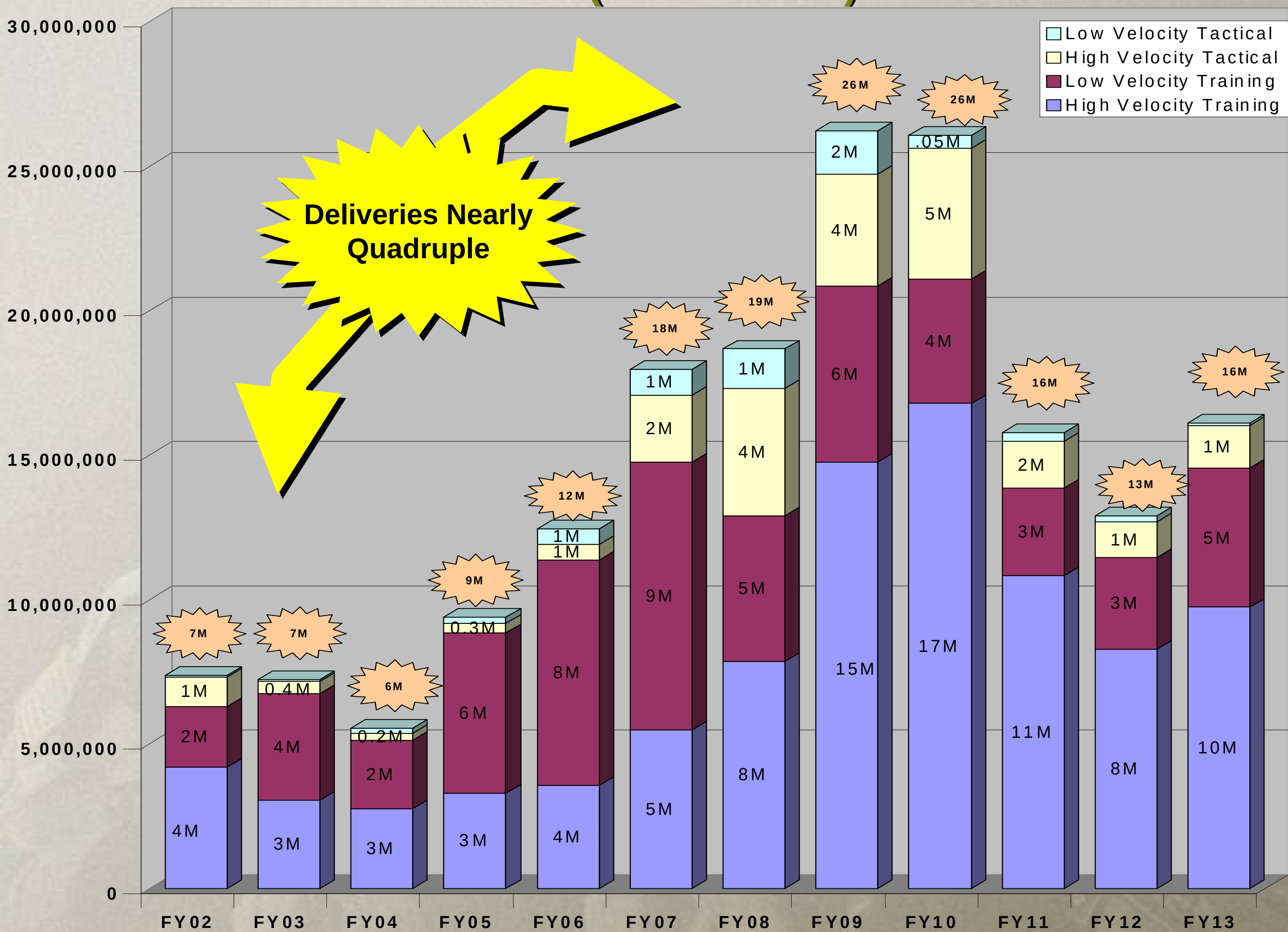
Future Challenges

- Iowa / Milan Competition (FY09)
- Follow-on Systems Contract (FY10)

DISTRIBUTION STATEMENT A:

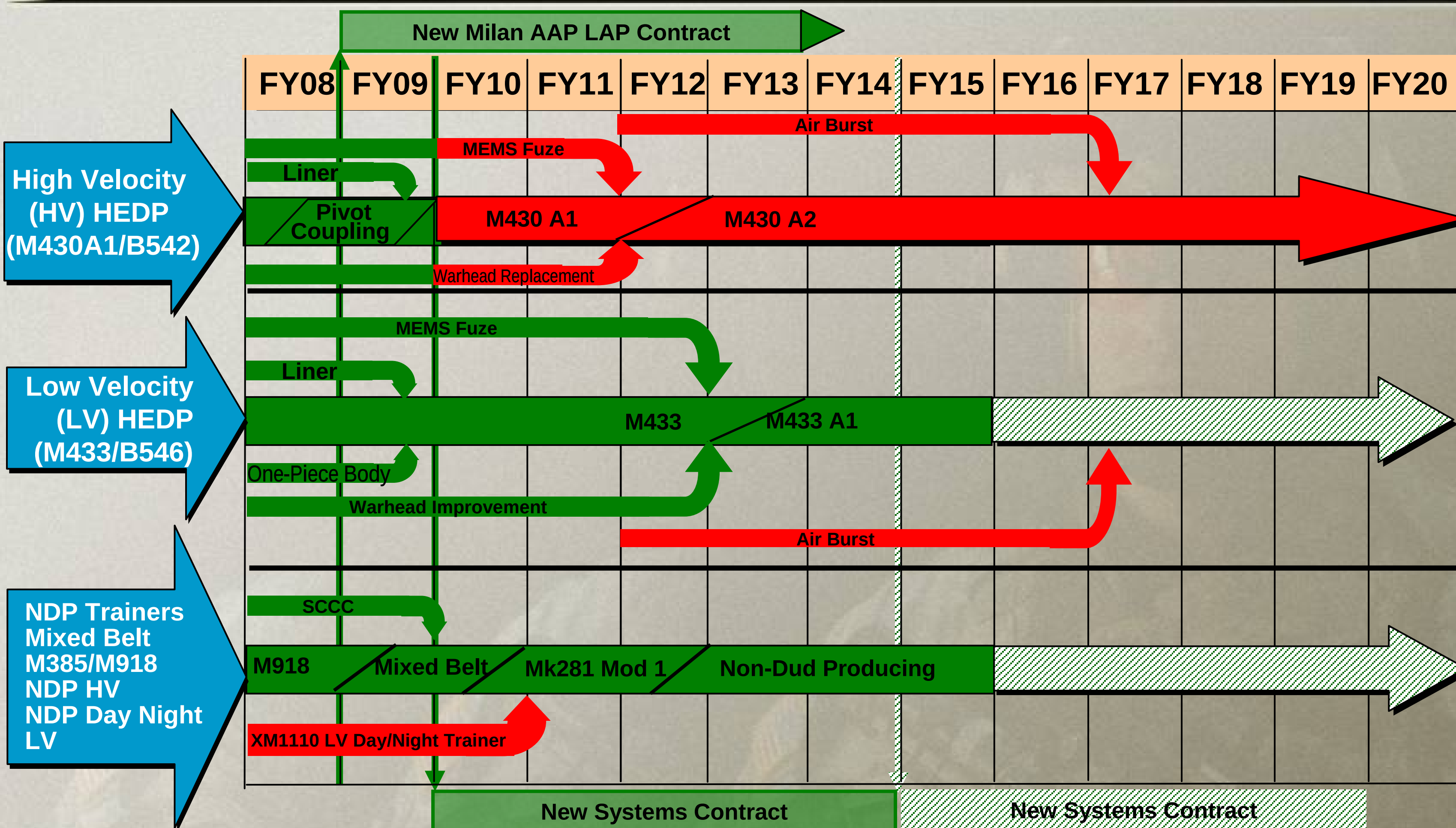
40mm Deliveries

(All Services)



DISTRIBUTION STATEMENT A:

40mm Roadmap



- Ammo Suite Satisfies ALL EXISITING 40mm Tactical Requirements
- HV and LV Trainers Will be Full NDP by FY12

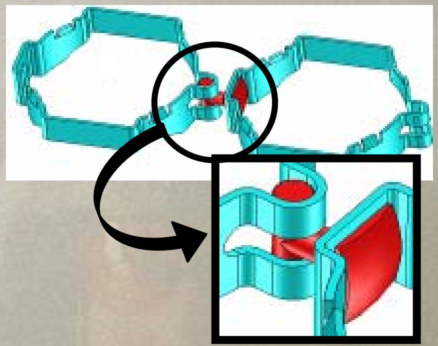
Projected

Funded

Unfunded

40MM NRE Efforts

- **Pivoting Couplings**
  - Combat Advantage: Link Next Belt of Ammo to One Currently Loaded in Mk19; No Need to Stop and Re-Load
  - Cost Savings: Add Single Round or Partial Belts to Existing Belt, so That Ammo is Not Wasted ($ 1M / yr)
  - Scheduled for Implementation in 4QFY08



- **Single Chamber Cartridge Case**
  - Eliminate Gun Stoppage Due to Excessive Base Plug Movement
  - Eliminate Bolt Face Erosion Due to the Leaking of Hot Propellant Gases Past Base Plug
  - Reduce Cost by Eliminating Base Plug and Closing Cup ($.30 / ctg), Easing Manufacturing Processes ($.30 / ctg), and Reducing Critical/Major Defect Inspections

- **M433 Improvement**
  - Improve Robustness of Design and Create More Consistent Function by Reducing Number of Components and Defect Inspections
  - Potential for Cost Savings Resulting from Less Complicated Design, Use of Production Methods Common with M430A1 HEDP, and Reduction of Touch Labor (Savings estimates not yet established)

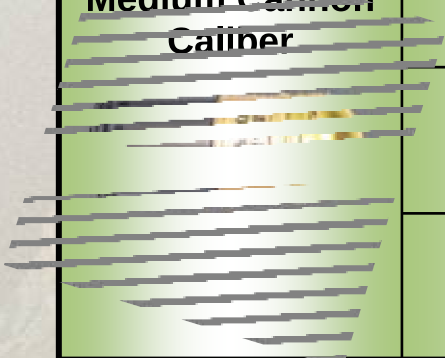
Future for Direct Fire Ammunition

Strategic Situation

- Production: At Capacity in Many Cases
- Requirements: Downturn on Horizon
  - Training - Replace Expenditures Only
  - Operational - Replace Expenditures & Build Stockpile
- Expenditures:
  - Training – recently at 40% requirement, historical at 70%
  - Operational – steady since FY06
- Stockpile: Increasing Daily…At or Nearing Objectives Requirements for Many Items
- FMS: On the Rise (223M Rounds So Far in FY08)

Challenges Ahead, But Opportunities Exist

Future Years Outlook

		Beyond 2008
Small Caliber 	5.56MM	Lower but Large FMS Orders Are Mitigating – Also Green Ammo
	7.62MM	Lower – New Green Ammo Reqts
	.50 Cal	Continued Sustained +100M/yr
	9MM	Steady Reqts
	Shot Shells, Calibers .45, .22, .30	Steady Reqts
Medium and Medium Cannon Caliber 	20MM	Steady AF & Navy Reqts
	25MM	Minimum Sustaining Buys
	30MM	30mm x 113mm: Higher Reqts for M789 & M788 Steady 30mm x 173mm: Slow Growth
	40MM	Min HEDP Buys – Training Ammo Switch to Non Dud Producing – Overall Lower Buys

Industry Opportunities

Technologies the Army is Looking to Obtain

- Improved Lethality
  - 5.56mm thru 40mm
- Cost Avoidance
  - Packaging, Materials, Reduced Weight
- Advanced Fuzing
  - Self Destruct, Increased Reliability, Cheaper
- Reduced Signature
  - Reduced Flash, Smoke, Non-pyrotechnic Tracer
- Improved Accuracy
- High Energy Propellants
  - Higher Velocity, IM Attributes, Temperature Insensitive

Respond thru System Contractors, NASTC, Unsolicited Proposal, Web Page, NWEC

DISTRIBUTION STATEMENT A:

EOM

Questions?

NEGEV Light Machine GUN (LMG) 5.56 mm

Speaker: Lt. Col. Mike Hartman
Israeli Defense Forces (IDF)

Commanding officer in charge of sniper rifles, assault rifles (A.R) and light machine guns technology & implementation at the IDF Ordnance Division 2000-2007

Background

- The Negev LMG is in service in the IDF since 1997.
- The Negev LMG was chosen by the IDF after extensive comparison tests initiated and made by the IDF ordnance corps among similar LMG's weapon systems.

Background

- During its service time few modifications were implemented in full coordination with the IDF infantry and ordnance corps in order to meet the IDF characteristics and current needs.
- The Negev LMG is the weapon of choice of the IDF because of it's versatility, durability and reliability .
- The Negev completed successfully the type classification procedure by the IDF.

The NEGEV as a fire power multiplier in the current and future battlefield

As part of the lessons derived from the Israeli Army operational activities and considering the current anti terror efforts the IDF decided to modify the Negev LMG to be lighter, shorter, more accurate and durable weapon.

One weapon - dual purpose

- The NEGEV offers 2 different combat applications: one as an assault rifle and the other one as a machine gun.
- 5.56 mm light machine gun with a high rate of firepower that can be set on a bipod or mounted on a vehicle.
- A configuration of Light assault rifle operated by a single warfighter.

Accurate and selective fire in Close Quarters Battle (CQB)

- The IDF specify the NEGEV LMG to be able to shoot both single and selective fire.
- The ability to use a variety of accessories for increasing the LMG’s effectiveness.

Accurate and selective fire in Close Quarters Battle (CQB)

- The picatinny rails placed in various positions on the NEGEV frame (not on moving parts or heated parts such as upper cover, gas port or barrel).
- Maintain zeroing for longer period of time.
- Extremely Low recoil (less than the average assault rifle).

Effectiveness in use at narrow alleys & in cavities inside APC's

•The NEGEV has the ability to be fully operated while stock is folded.

(total length in folded position is 26.7' only) allowing operation comfortably in narrow places such as alleys, inside houses, buildings & quick exiting from Vehicl

Effectiveness in use at narrow alleys & in cavities inside APC's

The LMG is equipped with an assault handle (versatile position, left or right) that allows stable shooting from shoulder, armpit or hip.

•The Negev is equipped with a detachable bipod which is durable and strong enough to allow a continuous rate of fire from all types of surfaces.

Hostile environment

patrols and special security missions in urban warfare

- The NEGEV LMG can be equipped with a rifle grenade (Simon device, Anti Tanks & Anti personnel grenades etc.)
- Capable of firing various types of ammo, including less-than-lethal charges and devices.

Hostile environment

patrols and special security missions in urban warfare

The NEGEV LMG can be equipped with sound suppressor to reduce noise and flash in close quarters environments.

- the NEGEV LMG has the ability for QBC (quick barrel change) at a minimum time of 1.3 seconds, while using various barrel lengths.

Durability & Safety

- The NEGEV is equipped with a gas regulator to allow full operation during sand storms, muddy areas, Snow, salt-water environment and other extreme weather & environmental conditions.

Durability & Safety

Ratchet mechanism prevents unintended closure before reaching the full cocking position

Once the weapon is set on the safety mode (Any position):

- The gun can't be cocked
- The trigger is deactivated

Technical Characteristics

Weight, weapon, unloaded:	15 LBS
Length, butt extended:	35 inch
Length, butt folded:	26.7 inch
Barrel length:	13 inch
Muzzle velocity:	3001 ft/s
Rate of fire:	850 - 1,050 rds/min
Max effective range:	3280 ft

Summary

- The IDF infantry doctrine based on the ability to use the new LMG as a versatile weapon system, easy to operate which can be used by any member of the party / company.
- As such, the Negev LMG weapon system meets or surpass the IDF requirements for light machine guns and therefore was chosen to be the weapon system of choice.

Contact Information

North East Technologies (NET) Ltd

P.O Box 1001
Kfar Sava, 44100 Israel
E-mail: Netech@ne-tech.com
Website: www.ne-tech.com

The Negev LMG is manufactures in Israel by

Israel Weapon Industries (IWI) Ltd.

Website: www.israel-weapon.com

The End

Non-Lethal Weapons Human Effects

5/22/08

711 HPW/RHDJ
Bldg 1168, Room 100E
8355 Hawks Rd.
Brooks City-Base, TX 78235-5147
james.simonds@brooks.af.mil

P: 210-536-2147
F: 210-536-2783
C: 210-577-0006
DSN: 240-2147

What are NLW Human Effects?

"The definition of 'Human Effects,' as applied to NLWs, may include any of the following: health effects to the weapon user, human targets, and humans near the target, and effectiveness of the weapon against human targets."

- Human Effects Process Action Team Report, Jan 2000

Key Definitions

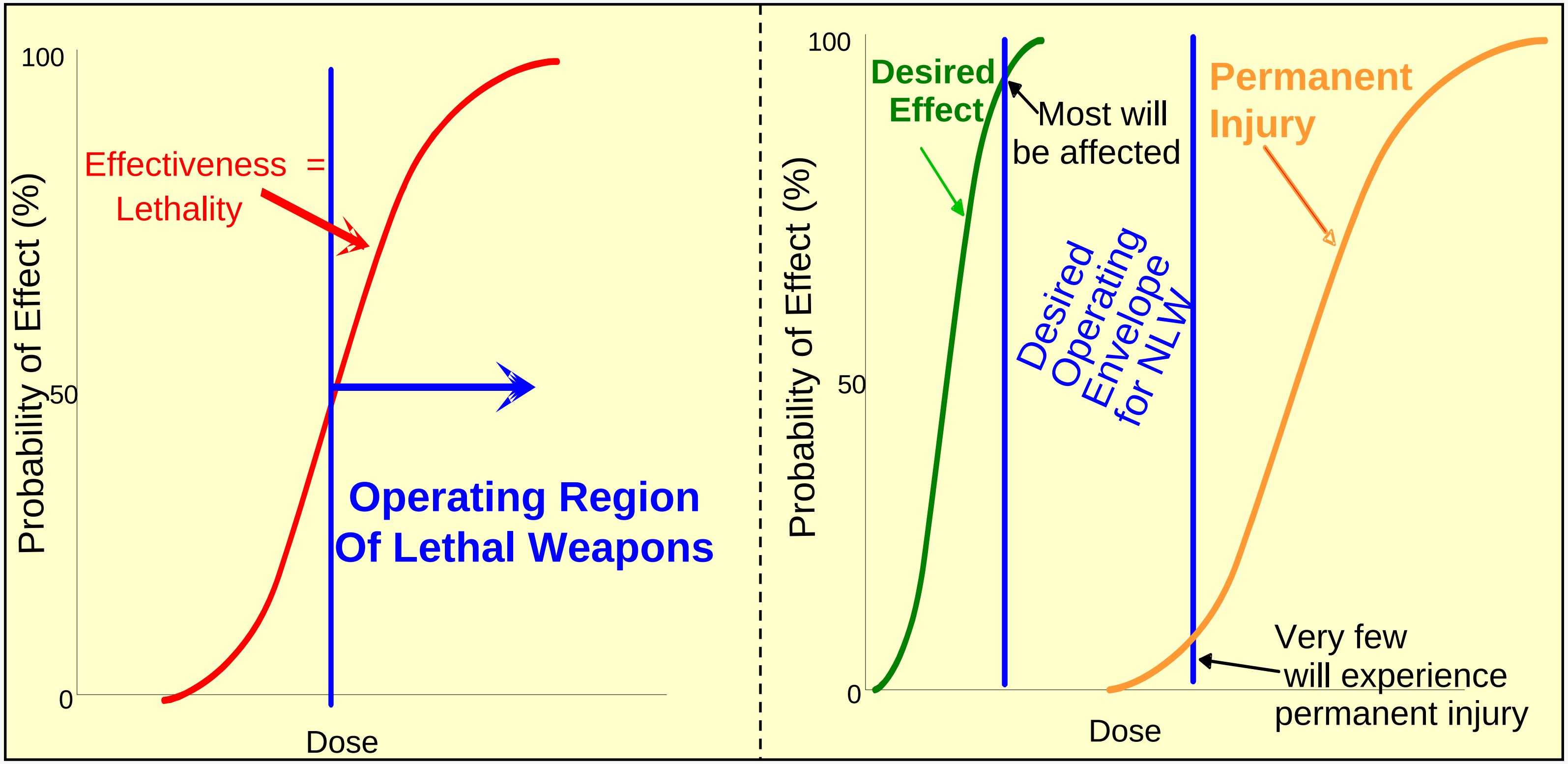
- **Non-Lethal Weapons:** Weapons, devices and munitions that are explicitly designed and primarily employed to immediately incapacitate targeted personnel or materiel, while minimizing fatalities, permanent injury to personnel, and undesired damage to property in the target area or environment. Non-lethal weapons are intended to have reversible effects on personnel or materiel. *(CBART)*

- **Injury:** A term comprising such conditions as fractures, wounds, sprains, strains, dislocations, concussions, and compressions. In addition, it includes conditions resulting from extremes of temperature or prolonged exposure. Acute poisonings (except those due to contaminated foods) resulting from exposure to a toxic or poisonous substance are also classed as injuries. *(JP 1-02)*

- **Permanent Injury:** Physical damage which permanently impairs physiological function that restricts employment and/or other activities of a person for the rest of his/her life. *(CBART)*

- **Reversibility:** The ability to return the target to its pre-engagement level of capability. It is usually measured by time and level of effort required for recovery of the target. *(NLRT)*

NLW Human Effects Characterization



- Generally, the goal of lethal weapons has been to maximize a single effect – lethality, while meeting the constraints of LOAC, logistics, cost, etc.

- For NLW, two competing objectives exist: cause a desired effect, while minimizing permanent injury.

- Understanding human effects is critical for legal/treaty reviews, policy acceptability, and warfighter awareness.

JNLWP Human Effects Process

JNLWD – Human Effects Branch
- Provide HE strategy
- Resource HE research
- Coordinate HE reviews

Human Effects Center of Excellence
- Portfolio (research) managers
  - Directed Energy, Blunt Impact, Acoustics, Etc.
- HE knowledge-base, Consultative Expertise
- HE – Modeling Analysis Program (HE-MAP)
- Human Effects Risk Characterizations

HERB
- Joint Service Board of Medical & Safety Officers
- Legal Treaty, & Policy SME representatives
- HE Safety, Training, Experimentation guidance

Treaty, Legal, Policy reviews

Program Manager

Milestone Decision Authority

HEAP
- Non-government Board of Bioeffects SMEs

Fielded Capability

Direction/coordination

Reports

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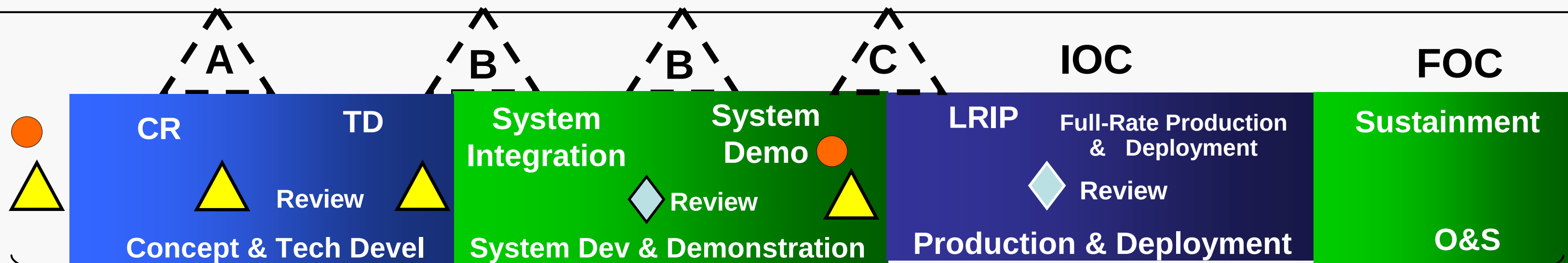
Human Effects Process and Acquisition

•Human Effects Review Board △ •Enumeration of significant health/operational risks •Recommendations to reduce or better characterize the risk	**•Human Effects Center of Excellence** •Repository of NLW data •Supplies human effects expertise to the PM

•Human Effects Advisory Panel: reviews performed as necessary based on Directorate needs ●



HECOE Support Throughout S&T and Acquisition

Pre-Mile A
- Basic research to verify HE mechanisms
- Operational utility studies
- Initial estimate of safety margin
- Front-end look at new technology

Concept Refinement
- Technology Reviews
- HE Support to AoMCs
- Preliminary payload assessment
- Mission needs definition
- Human Effects Resource Estimates

Tech Development
- Draft of THEEP*
- Begin studies to quantify and reduce risk
- Component design guidance
- Preliminary Risk Characterization

System Integration
- Execute THEEP
- Studies to determine operating envelope

System Demonstration
- T&E Support
- Live fire animal/human testing (if appropriate)
- Full Risk Characterization

LRIP, Full-Rate Prod & Deployment
- Field data collection
- Refine modeling and simulation tools

*Target Human Effects Evaluation Plan

Increasing human effects knowledge, decreasing risk

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	Technology Readiness Levels (TRL)		Human Effects Readiness Levels (HERL)
		Acquisition Interim Guidance (30 May 2003)	
System Field Test and Operations	**9**	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. Examples include using the system under operational mission conditions.	Human or surrogate participation in operation testing. Data validated from live fire experimentation and fielding.
System / Subsystem Development	**8**	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.	Human or surrogate tests in field environment with mature prototype systems under realistic conditions.
	7	Prototype near, or at, planned operational system. Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in an operational environment such as an aircraft, vehicle, or space. Examples include testing the prototype in a test bed aircraft.	Human studies or surrogates in lab or field environments with prototype systems under specific, highly controlled, exposure conditions.
Technology Demonstration	**6**	Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in simulated operational environment.	Non-human primate or large animal models confirm safety. Provide basis of limited human studies in laboratory to examine effectiveness.
Technology Development	**5**	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment. Examples include "high fidelity" laboratory integration of components.	Studies in large animal models to more fully characterize effects, demonstrate technology effectiveness and safety.
	4	Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of "ad hoc" hardware in the laboratory.	Bioeffect mechanism accepted by scientific community; small animal studies conducted to develop dose-response relationships.
Research to Prove Feasibility	**3**	Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of technology. Examples include components that are not yet integrated or representative.	Bioeffect mechanism clearly identified; studies to determine dose-response relationship planned or began in small animal models.
	2	Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.	In vitro and cellular models used to study postulated bioeffect mechanisms; important dose-response parameters are postulated.
Basic Technology	**1**	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties.	Bioeffect mechanism postulated through paper studies, theoretical analysis.

Payloads and Associated Human Effects Knowledge

- **Variety of payloads and non-lethal stimuli with varying degrees of confidence in understanding of human effects**

- **Blunt Impact:**
    - Validated injury prediction M&S tool (HE-MAP's Advanced Total Body Model)
    - Behavioral research difficult, efforts being made to develop predictive link between blunt impact and behavioral modification

- **Acoustics:**
    - Injury thresholds well established
    - Effectiveness thresholds exist for impulse noise

- **Electromagnetic Spectrum:**
    - M&S tools and data exist for much of the EM spectrum for both injury and effectiveness

- **Limiting factor in human effects is generally ability to predict behavioral response to exposure of non-lethal stimuli**

Human Effects Characterization Process

-**Transition in way of doing business:**

- Used to do retrospective analysis
- Now will provide prospective analysis
- Design optimization
- Effects based design

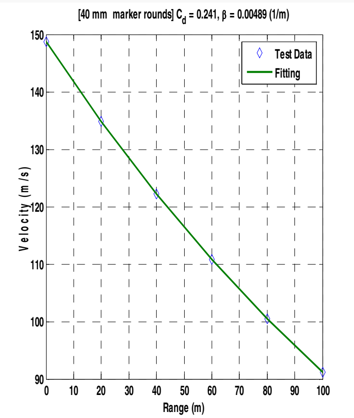
- **5 step characterization process:**

- Determine exposure
- Determine body response
- Map to injury correlation
- Determine behavioral response
- Determine if engagement meets mission objectives

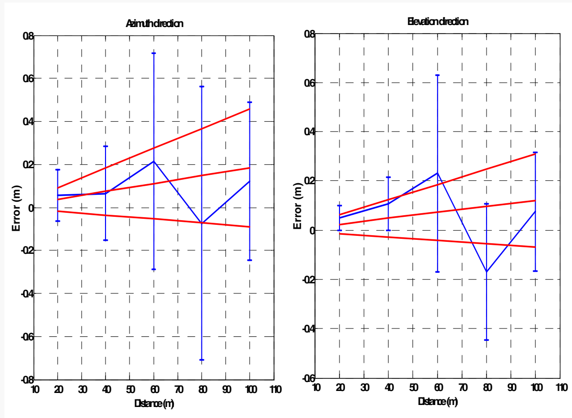
Industry and Human Effects Modeling and Simulation

- M&S analysis requires JNLWD or Service interest
- Data needs for analysis:
    - Sample munitions, projectiles, force-time histories, etc.
    - Projectile material, composition of grenade fill, etc.
    - Muzzle velocities
    - Accuracy/dispersion data
    - Light, sound, pressure, heat flux
    - etc.

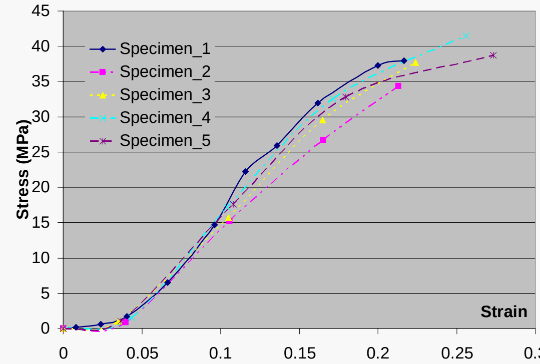
Determine Exposure

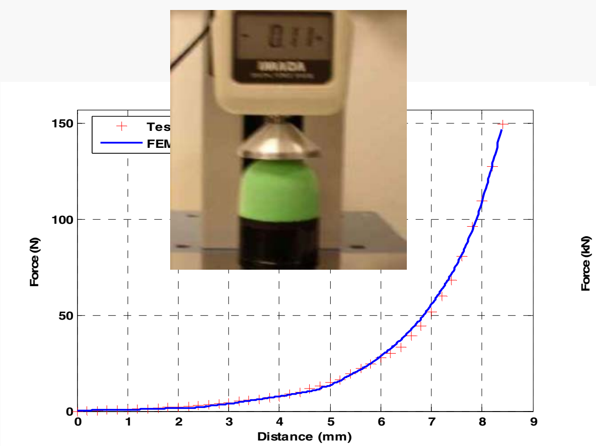


Calculation of dragging coefficient

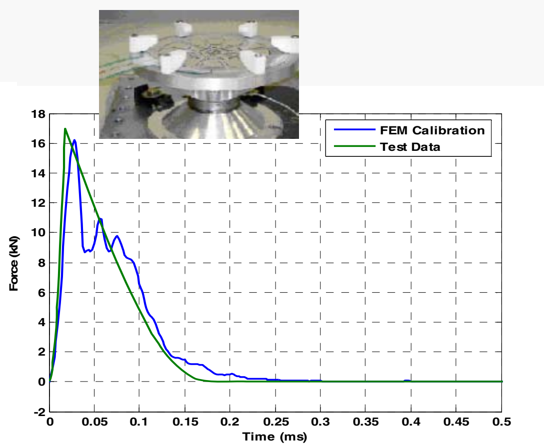


Calculation of accuracy parameters

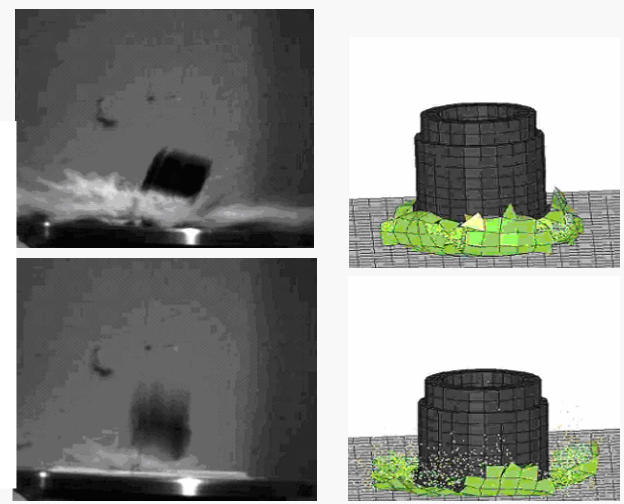




Static calibration



Dynamic calibration



Projectile modeling and impact simulation

Human Effects Modeling Analysis Program (HE-MAP)

Application Products

HEMAP-Web Application: web analysis interface
- Quick Estimator (HEQE)
- Effects Based Analysis (EBA)
- Design Optimization (DOA)

HEMAP-MSG Application: graphical simulation
- "Virtual training"
- Learn to use NLW
- Practice engagement techniques

Database of NLW system and payload based effects data
Import into HEMAP-web and HEMAP-MSG

Research & Development

(testing → payload characterization → delivery → effects outcomes

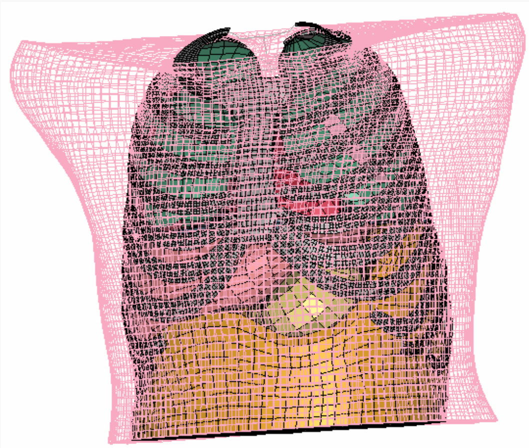
Responses/Effects	Payload delivery	Source characterization	Testing
ATBM	Projectile /fragment Delivery	Accuracy/ Impact Characterization	Firing/impact Accuracy Test
INJURY	Blast Delivery	Blast source Characterization	Blast test (BTD)
BURNSIM	Heat Delivery	Heat source Characterization	Explosion (heat flux)

IMPULSE NOISE, RF, OPTICAL, ELECTRICAL (TASER), …

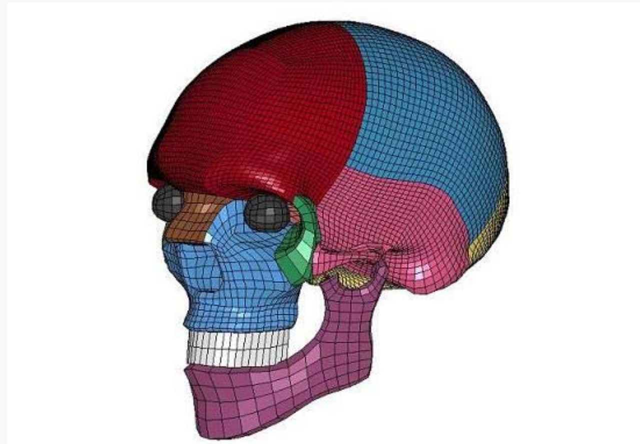
HEMAP Research: develop, integrate, validate, and verify models, data, and analysis methods
- Model development
- Model integration
- Model VV&A
- Data collection (Human, PMHS, Animal)
- Testing method, procedure, standard

- R&D: better integration of human effects models for all types payloads of interests;
- Application products: better support users' needs for analysis, design, training capabilities

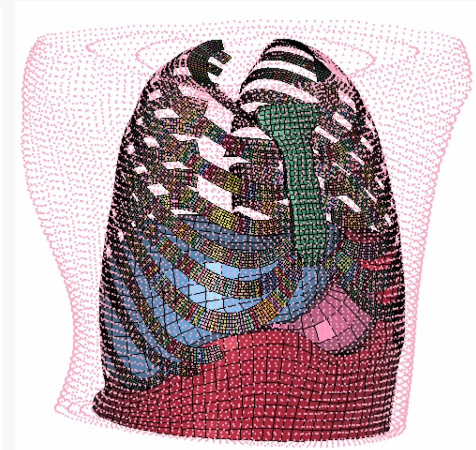
Predict Body Response and Injury



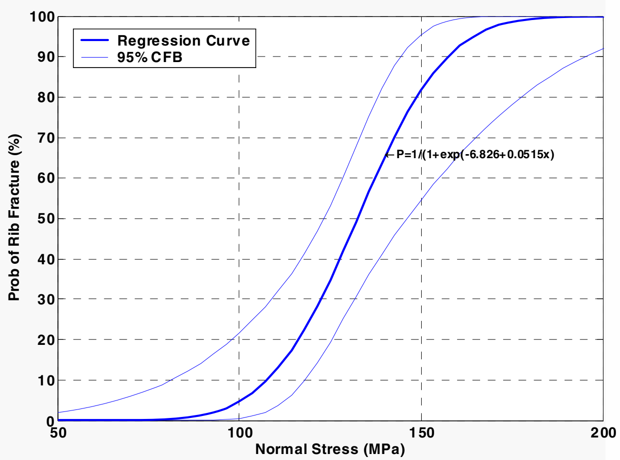
Thorax FE modeling



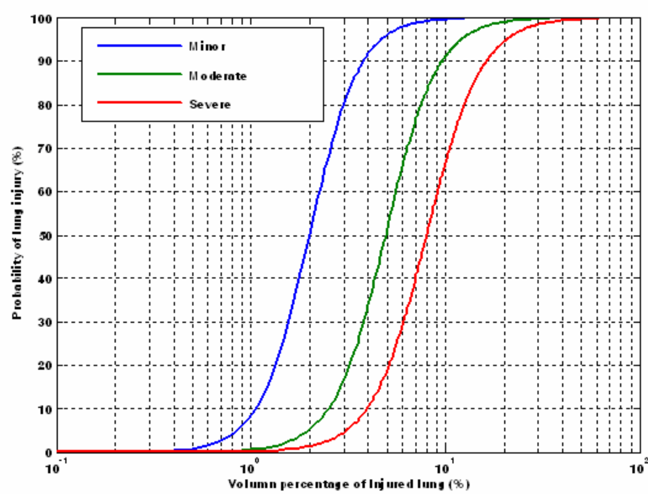
Head FE modeling



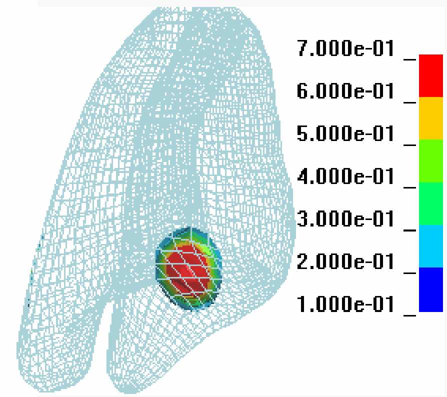
Abdominal FE modeling



Rib fracture correlation



Lung injury correlation



Mission Assessment

The software model and simulation environment can account for complex human effects and behavior outcomes

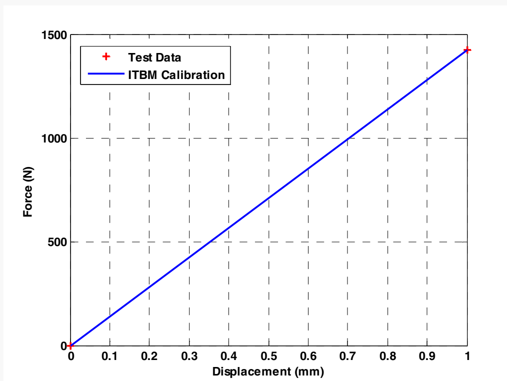
Using semi-immersive technologies (headset and weapon) to engage in the training in Virtual Reality. The headset can be connected wirelessly to the main station and display.

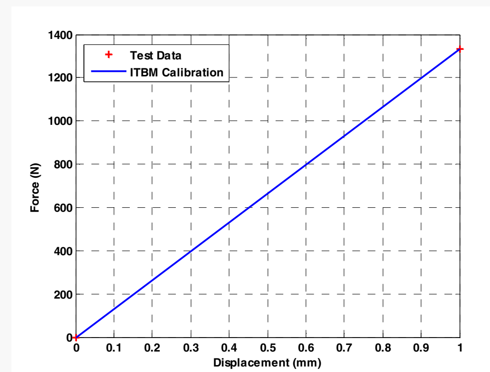
Blunt Impact Example

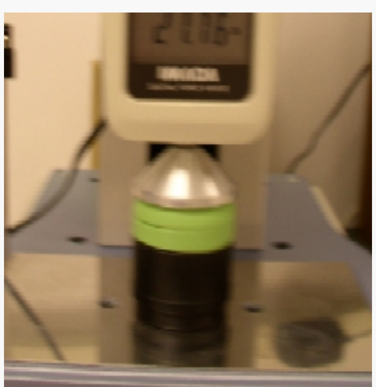
- **NL PM asked HECOE to perform analysis for two candidate projectiles**
- **Injury analysis expected to aid PM in down-selecting to final design**

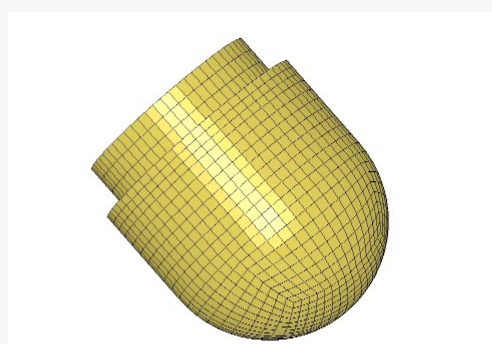
Exposure

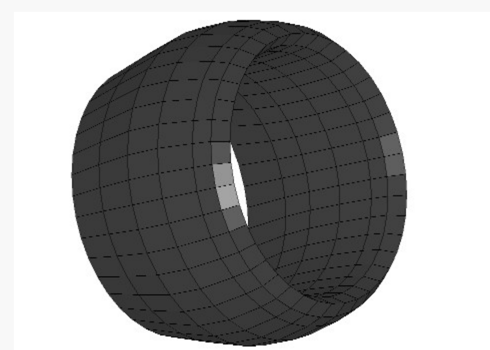
- Determine down-range velocities (impact velocities)
- Determine accuracy and hence probability of strike and strike location
- Mechanical characterization of projectiles and Finite Element (FE) model development





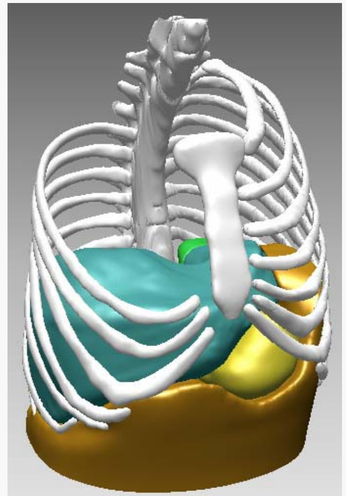


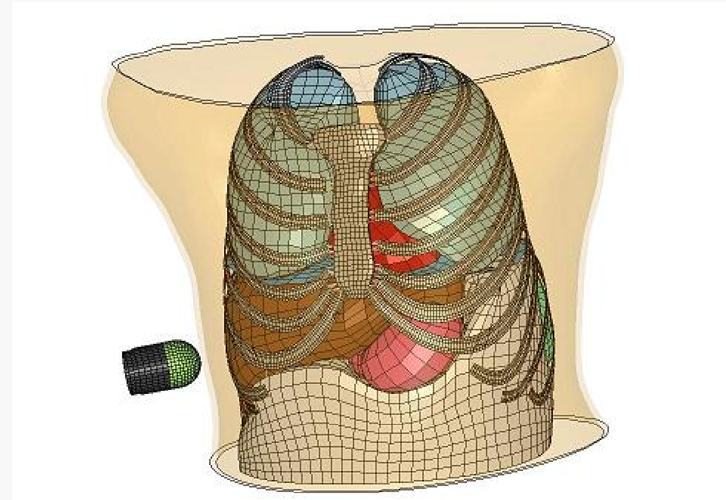


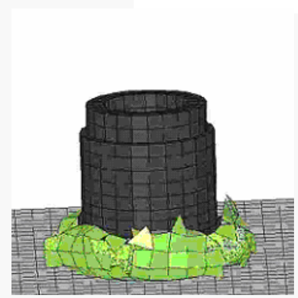


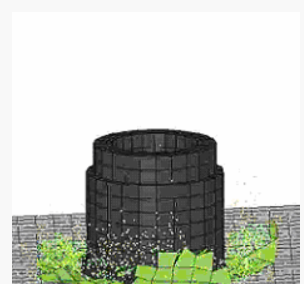
Advanced Total Body Model (ATBM)

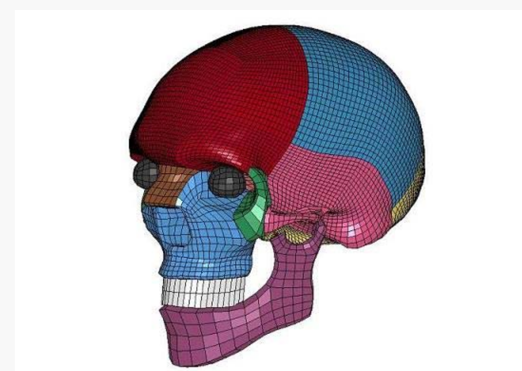
- Advanced Total Body Model (ATBM) is a JNLWP sponsored finite element based blunt trauma injury prediction model
- Biomechanically based, applicable for NLW impacts and validated against animal and cadaveric data
- Predicts a variety of injuries for the head, neck, thorax, abdomen, skin and extremities
- Includes design optimization and probability of hit modules
- Established projectile characterization process including static and dynamic loading to develop projectile FE model





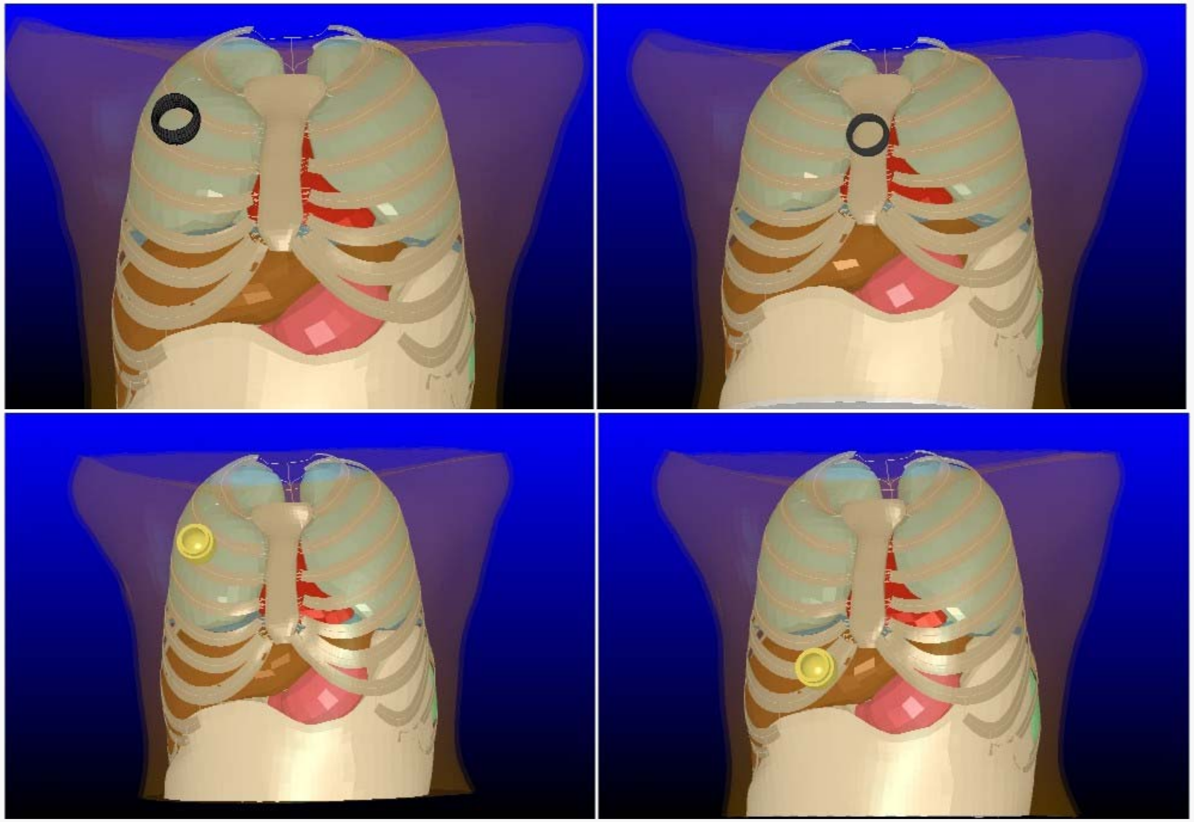


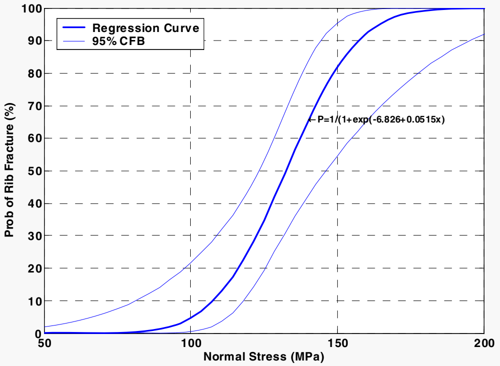


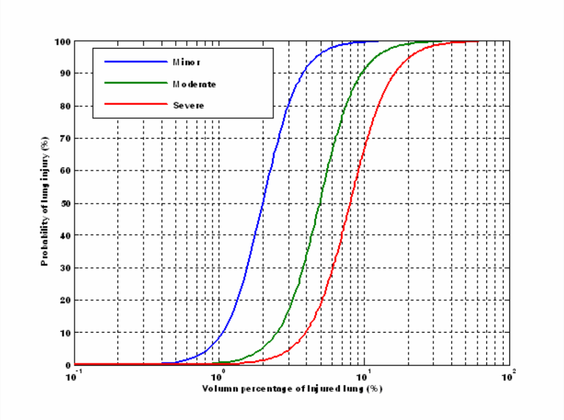


Body Response and Injury Correlation

- Thousands of FE simulations performed for various impact velocities and impact locations
- Yields predicted body response (i.e. strain in the rib) as a function of applied stress
- Predicted response mapped to injury correlations for various tissues and organs
- Injury predictions generated for various injury modalities







Summary

- Understanding the human effects and effectiveness of non-lethal weapons is fundamental to their development.
- The JNLWP has developed a process to facilitate understanding these human effects and to support the JNLW community.
- The process will be codified in a Department of Defense Instruction on NLW Human Effects Characterization.
- Modeling and simulation tools aiding non-lethal community in predicting effects and effectiveness from non-lethal weapon deployment

Improved Flash Bang Grenade (IFBG)

National Defense Industrial Association
Small Arms Systems Symposium
22 May 2008

Ned Carroll
Jacobs Technology Inc.
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Distribution Statement A - Approved for Public Release

Background

- Flash-Bang Grenade Capability Production Document Signed 11 Feb 2008
  - Increment I – Mk 141 – Removed from Service Use Due to Safety Issues
  - Increment II – BTV-1 – Currently used by USMC
  - Increment III – IFBG – Follow-on Spiral with Increased Capability and Enhanced Safety Characteristics

Mk 141

BTV-1

IFBG Prototype

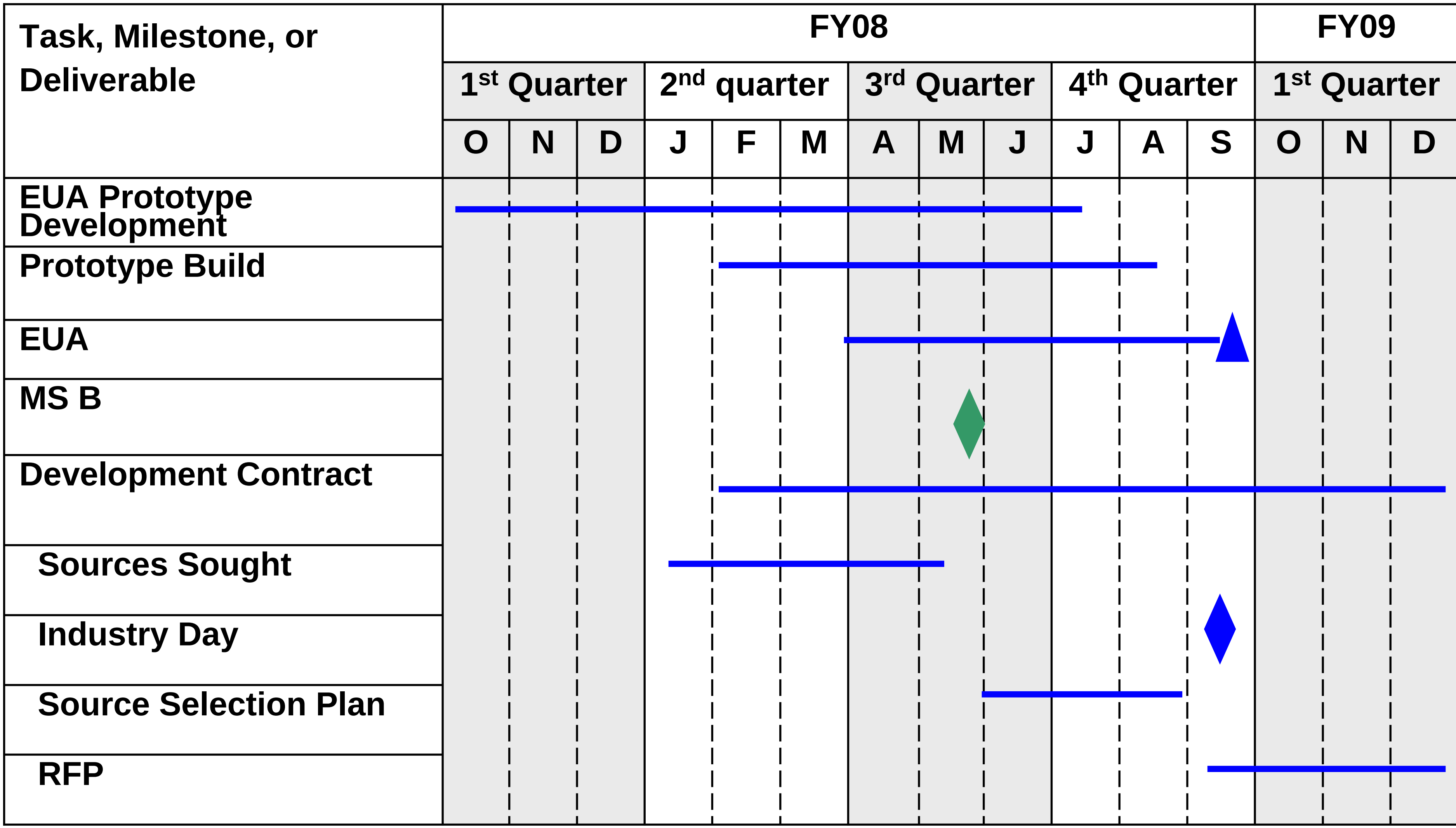
Project Goals

- **DESCRIPTION:**
- Develop and Procure a Safer, More Effective, Hand-employed Flash-bang Grenade With Greater Light Output That Increases Duration Of Flash-blindness and Generates Debilitating Sound Pressure Levels.
- Removal of Harmful Perchlorates Improves Safety to The Warfighter, and Improves Environmental, Health & Safety Compliance
- **FISCAL YEAR OBJECTIVES:**
- Technical Development and Testing Prototypes
- Early User Assessment
- Milestone B Decision
- Signed Capability Production Document (CPD)
- Initiate Competition for Bid Sample Testing

Development Goals

- Develop and Procure a Flash-Bang Grenade with the following Characteristics:
  - Increased Duration of Human Incapacitation
  - All Human Effects are Reversible – No Permanent Injuries
    - Increase Total Light Output to Increase Duration of Reversible Flash-Blindness **(Threshold = 10 seconds)**
    - Maintain Pressure Levels to Safely Startle / Confuse Target Subjects
    - Elimination of Harmful Perchlorates in Payload. Perchlorates have a Negative Impact on the Environment and the Warfighters that Train with & Use Flash-Bang Grenades

Near Term Schedule



Sources Sought Information

- Sources Sought Synopsis was Released on 31 Jan 08. Copies Available today
- AFRL Flash-Blindness & Glare Modeling Publication (Kosnick & Smith, May 2003) Also Available Today (Approved for Public Release, Distribution Unlimited)
- Request for Proposals will be Released in September 08
- Industry Day will be Held in September 08 Immediately after release of the RFP to Clarify Requirements and Evaluation Methods

Questions?

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M870REV SHOTGUN

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RDECOM

Malcolm Baldrige National Quality Award 2007 Award Recipient

ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER PICATINNY ARSENAL, NJ

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Development of the M870REV Non-Lethal Shotgun System for use with the EM113REV

Kevin G. Adams, R&D Gunsmith, Armament Technology Facility

M870REV SHOTGUN

INTRODUCTION

- The United States Army Military Police expressed a requirement in obtaining a riot control vehicle to meet the unique mission needs of entering prisoner of war camps.
- In executing their mission, the US Army Military Police faces the risk of lethal weapons falling into the hands of prisoners when using standard small arms weapons systems and must consider not using lethal force in certain situations.

M870REV SHOTGUN

REQUIREMENTS

- The US Army Military Police requires a vehicle employing a Non-Lethal weapons system that will be capable of engaging and defeating a variety of barricades and personnel targets, while minimizing the potential for soldiers to be injured or captured.
- It is required that this vehicle be armed with a Non-Lethal weapon platform, using standard 12ga non-lethal ammunition.

M870REV SHOTGUN

DEVELOPMENT

- In 2005 the Armament Research, Development and Engineering Center at Picatinny Arsenal began development of an innovative approach to using non-lethal shotguns for riot control in the theater internment facilities in Iraq.
- The non-lethal weapons part of the project was given to the Research & Development Gunsmith Shop at the ARDEC Armament Technology Facility (ATF).
- A pump shotgun was needed since the weapon system had to fire M1012 and M1013 non-lethal rounds.

M870REV SHOTGUN

DESIGN

Current design fielded in October 2006 includes:

- Enhancements to structural design of the shotguns to handle the unique impulses experienced by the hull-mounted shotgun.
- Ventilation concept borrowed from the early Bradley Fighting Vehicles.
- An immediate, armor-protected non-lethal response that can be used to deter riots or restore order.

M870REV SHOTGUN

EM113REV

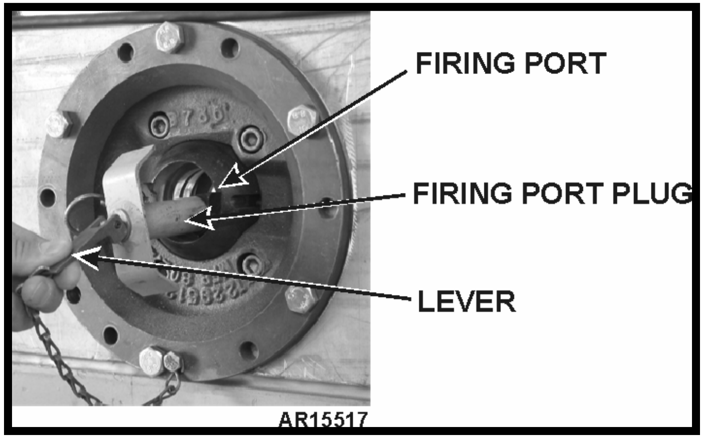
M870REV SHOTGUN

M870

- The ATF R&D Gunsmith shop started with the 12 gauge Remington M870 Police shotgun since it has a steel receiver and is in the US Army system.

M870REV SHOTGUN

M231 FIRING PORT



- Port for the M231 5.56mm firing port weapon from the M2 Bradley Fighting Vehicle.
- This port had already been tested and safety released.
- Threaded collars from the M231 barrels were used to attach the shotguns to the firing port.

M870REV SHOTGUN

DESIGN

On the first prototype the following modifications were done to the shotguns:

- Replace buttstock with pistol grip.
- Replace standard forearm with pistol grip forearm.
- Bore out and TIG weld the M231 threaded collar to the shotgun barrel.

M870REV SHOTGUN

TESTING

- Initial ATF testing in a test fixture with 00 buckshot, for increased recoil, showed no problems with the design.
- Aberdeen Proving Grounds (APG) testing in the EM113REV, using M1012 and M1013 non-lethal ammunition, showed problems with the brazed joint on the magazine support breaking and the barrel pulling out of the receiver.

M870REV SHOTGUN

TESTING

- High speed video using 00 buckshot, in the EM113REV showed that there was some flexibility in the test fixture and none in the actual vehicle.

- It also showed that the pistol grip forend allowed the operators to exert forces on the magazine joint like a slide hammer, exceeding the strength of the joint.

- In a normal configuration and fired from the shoulder, all the firing and recoil forces are directed rearward and all the weapon components are compressed against the shoulder/buttstock.

- In the modified configuration, all the recoil forces are still directed rearward, but because the muzzle end is attached to the mount, all the forces caused the components to separate.

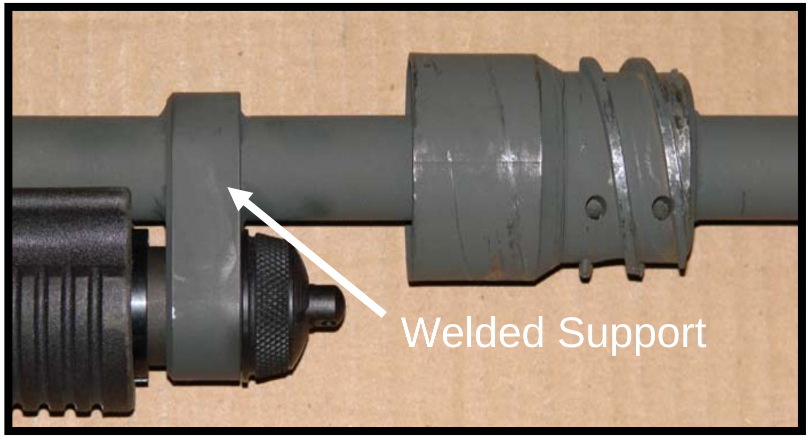
M870REV SHOTGUN

SOLUTIONS

- The ARDEC design team experimented with various ideas through computer simulation and modeling and came up with several solutions.

- The ATF R&D Gunsmith shop built two of the leading designs for further live fire testing.

DESIGN – Two New Prototypes



- Welded figure-8 magazine support
- Two 10-32 receiver screws
- Solidly welded M231 collar

- Spring surrounding barrel, allows M231 collar to absorb some recoil.
- Figure-8 magazine support was TIG welded to the barrel.
- Added two 10-32 machine screws through the left side of the receiver, into the barrel extension.

M870REV SHOTGUN

FURTHER TESTING

- During testing at the ATF in the EM113REV using high speed video and 12 gauge 00 buckshot, it was found that the spring loaded design gave a double recoil impulse to the weapon.
- The non-spring design worked better and was easier to manufacture.
- This is the design that was settled upon

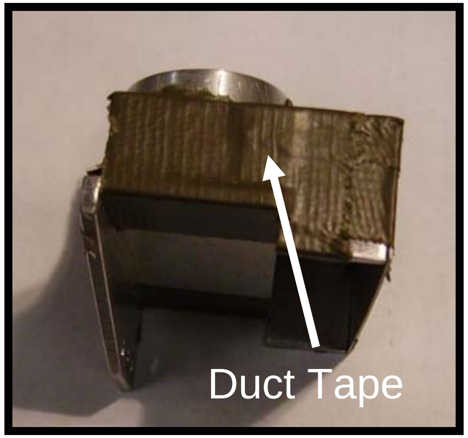
M870REV SHOTGUN

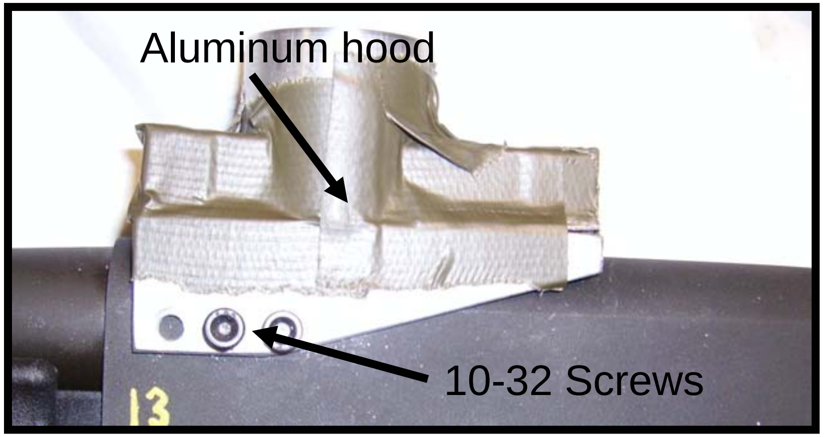
TESTING: ATF

- Five guns built.
- M1012 and M1013 non-lethal ammunition fired through each weapon.
- Results: build-up of irritating fumes inside the EM113REV.

M870REV SHOTGUN

FUME HOOD: DEVELOPMENT





- Attached using the 10-32 barrel retention screws
- M2 Bradley Cabin exhaust fans used with hoods

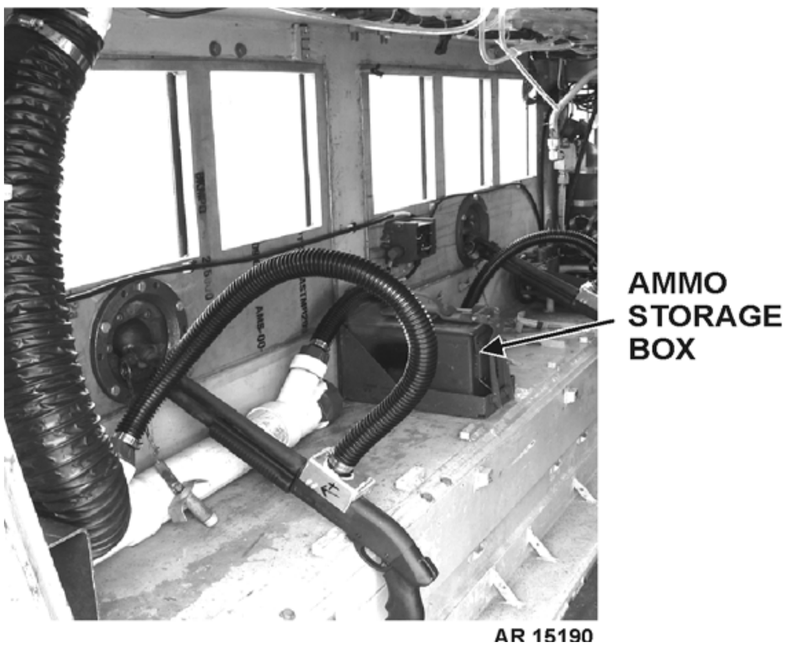
M870REV SHOTGUN

FUME HOOD: TESTING

- Hood tied into the exhaust fans using PVC pipe and plastic vacuum cleaner hose.
- Initial testing at ATF with aluminum prototypes.
- Further testing at APG with the TIG welded prototype.
- The weapon system was safety released and fielded.

M870REV SHOTGUN

FIELDED DESIGN



M870REV SHOTGUN

AWARDS

- EM113REV and its weapon systems validated by combat veterans
- US Army's Top Ten Greatest Inventions Award 2006.
- Patents pending on EM113REV and M870REV.

Malcolm Baldrige National Quality Award

2007 Award Recipient

M870REV SHOTGUN

2006 US ARMY TOP TEN GREATEST INVENTIONS

ANY QUESTIONS?

real time fire control solution for individual and crew-served direct firing infantry weapons - algorithm and implementation

A. Kuhrt
H. Rothe

Chair for Measurement and Information Technology

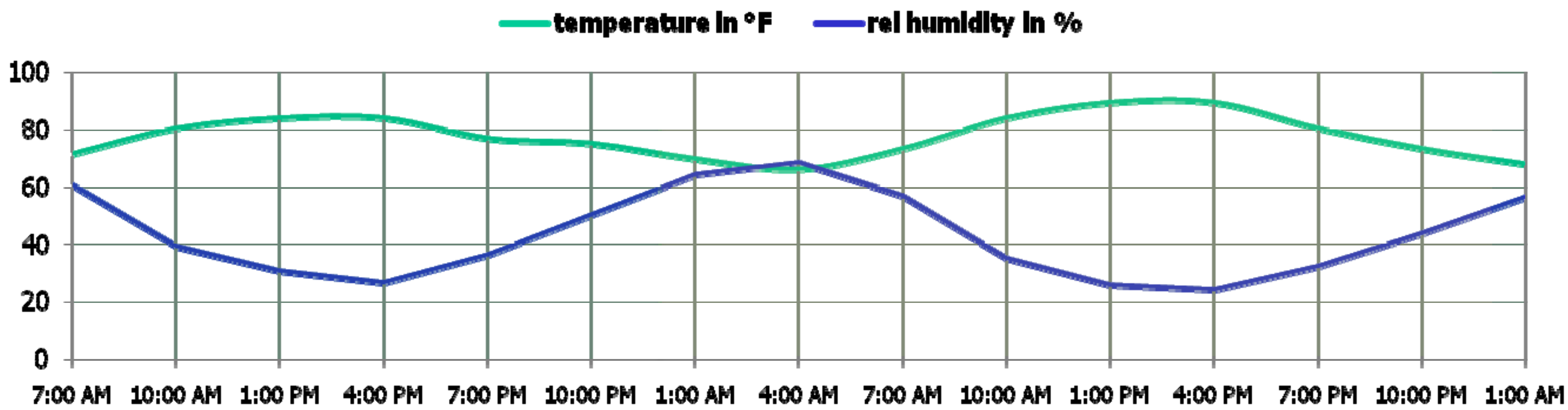
Univ. Prof. Dr.-Ing. habil. Hendrik Rothe

Mazár-e-Sharif

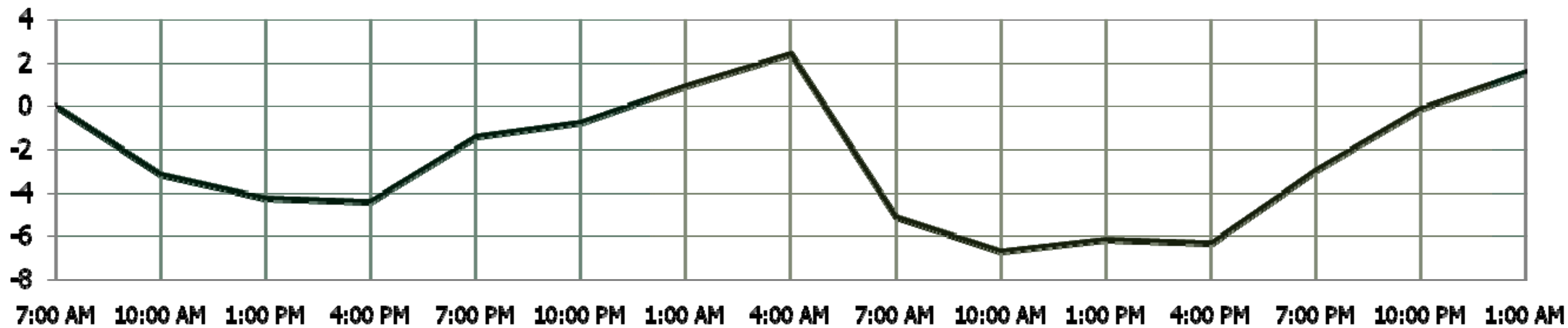
08 0730 D may 08

rH: 60% T: 71°F

target range: 1500m



click adjustments due to weather conditions



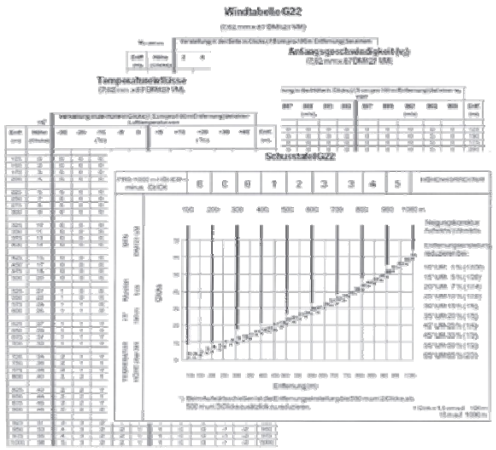
target range: 1500m

Mazár-e-Sharif

Agenda

1. Status quo
2. Requirements
3. Theoretical Approach
4. Algorithm
5. Testing and Accuracy
6. Performance
7. Implementation
8. Conclusions

Status Quo

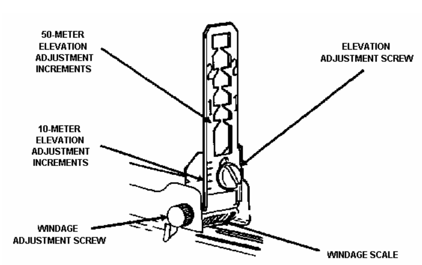


LRF

DMC

PDA

GPS



thermal sight

video sight

Requirements

requirement	fulfilled
range- and crosswind	
arbitrary angle of site	
muzzle velocity	
coriolis force	
magnus force	
multiple ammunitions	
height dependent air temperature	
height dependent air pressure	
user-defined targeting sights	
time fuze capability	

Approach

Point Mass Trajectory Model

↓

only drag and gravity acting on projectile

↓

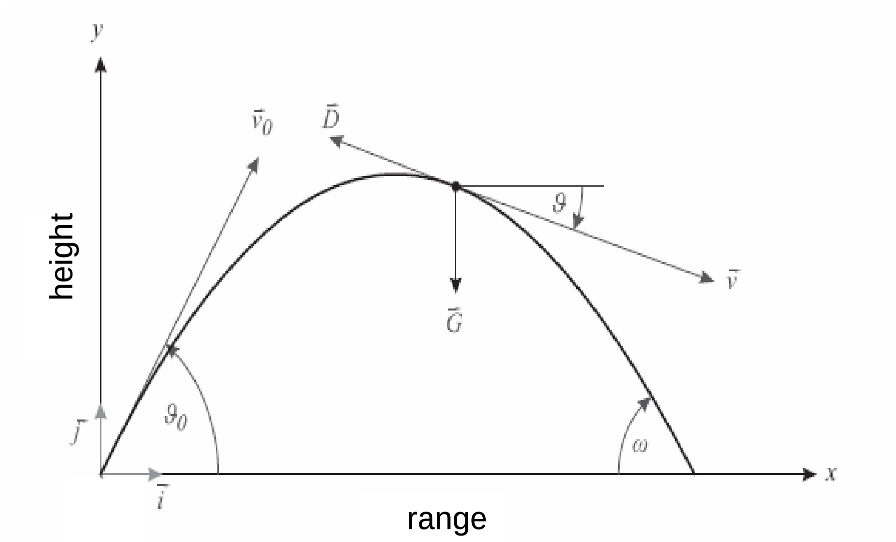
adding flat fire assumptions

↓

Adding generalized power drag law

↓

analytically solvable set of differential equations of motion



$$
\begin{aligned}
\dot{x} &= v\,\cos(\vartheta), & x(t_0) &= 0;\\
\dot{y} &= v\,\sin(\vartheta), & y(t_0) &= 0;\\
\dot{v} &= -\frac{D}{m} - g\,\sin(\vartheta), & v(t_0) &= v_0;\\
\dot{\vartheta} &= -\frac{g}{v}\,\cos(\vartheta), & \vartheta(t_0) &= \vartheta_0.
\end{aligned}
$$

Approach

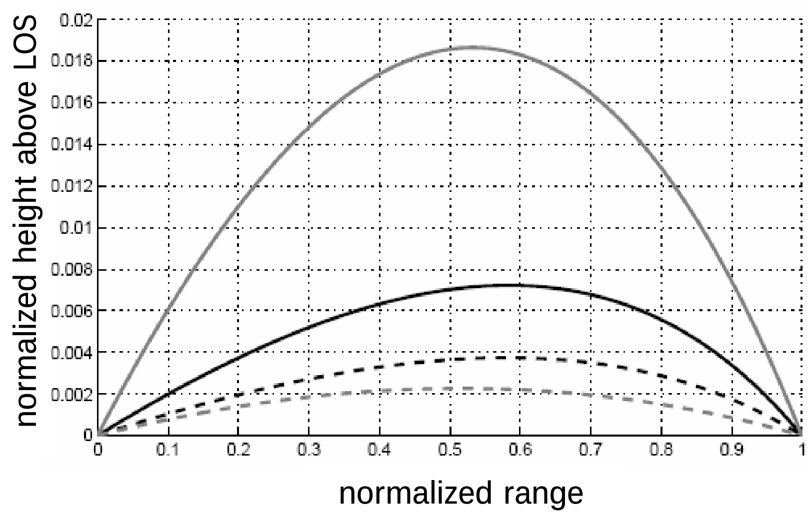
Point Mass Trajectory Model

only drag and gravity acting on projectile

adding flat fire assumptions

Adding generalized power drag law

analytically solvable set of differential equations of motion



$$R := \frac{x_{max}}{y_{max}}.$$

$$\vartheta_0 < 5^\circ$$

Approach

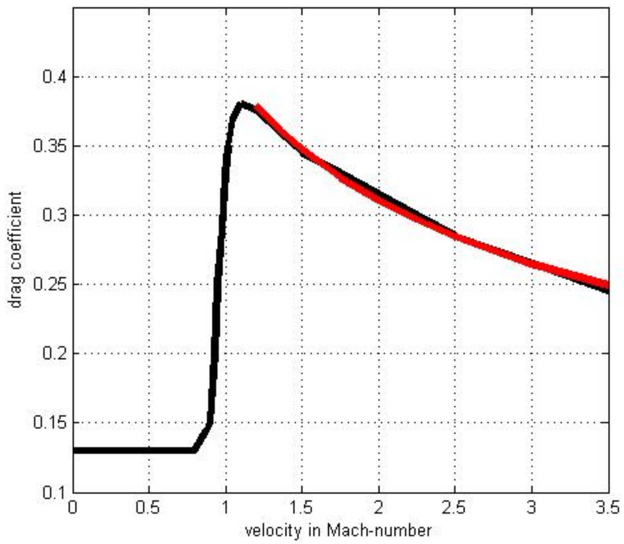
Point Mass Trajectory Model

only drag and gravity acting on projectile

adding flat fire assumptions

Adding generalized power drag law

analytically solvable set of differential equations of motion



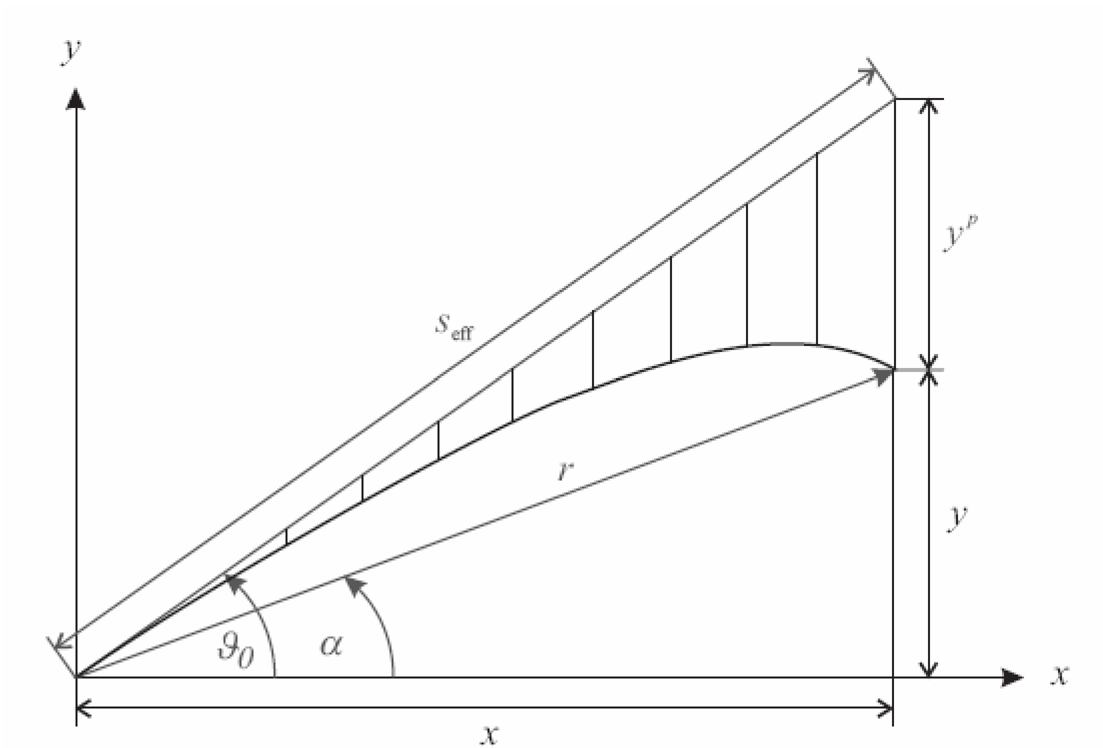
$$C_D := C_0 \, \mathrm{Ma}^{-n}$$

Algorithm

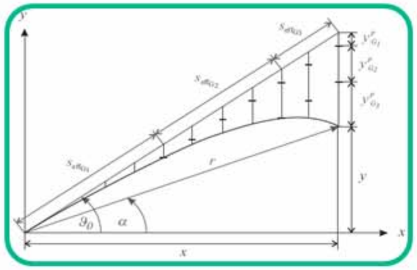
- ✓ super elevation
- ✓ striking veloctiy
- ✓ time of flight
- ✓ strinking energy

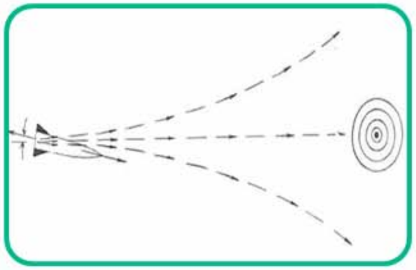
calculated using

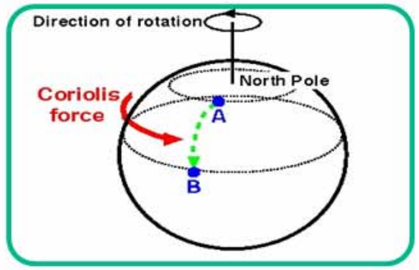
- o Mach dependent analytical solutions
- o splitted solutions for slant range and gravity drop
- o gravity corrected projectile velocity

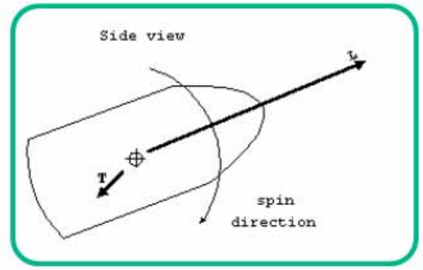


Algorithm









Multi Region Drag Fitting

- *Extends range of validity*

Range- and Crosswind

- *Using perturbation mathematics*

Coriolis Force

- *Using McCoy's approximation*

Spin Deflection

- *Using NATO STANAG 4355 Appendix F approximation*

Algorithm

requirement	fulfilled
range- and crosswind	✓
arbitrary angle of site	✓
muzzle velocity	✓
coriolis force	✓
magnus force	✓
multiple ammunitions	✓
height dependent air temperature	✓
height dependent air pressure	✓
user-defined targeting sights	✓
time fuze capability	✓

Testing and Accuracy

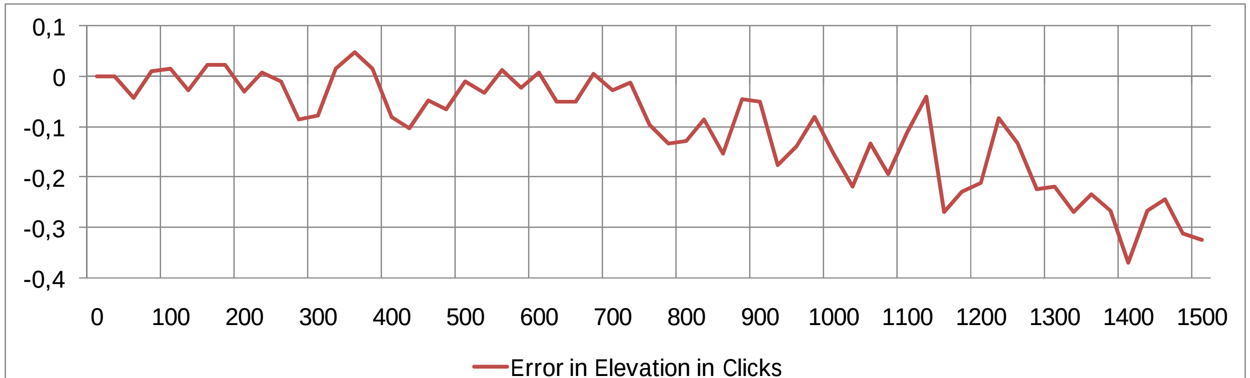
- *Life firing tests* ✓
- *Test against 6DOF-PRODAS model* ✓
- *Test against in-service firing tables* ✓
- *Test against numerical implementation of model* ✓

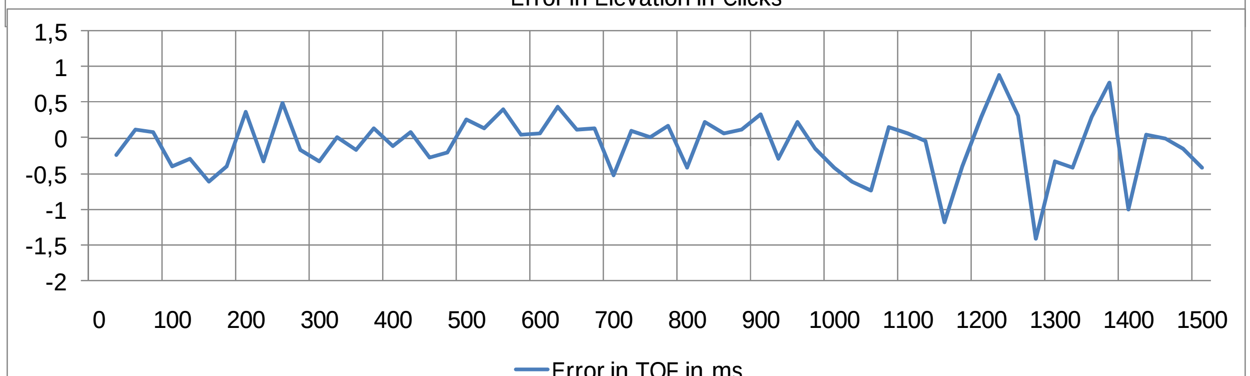
Accuracy

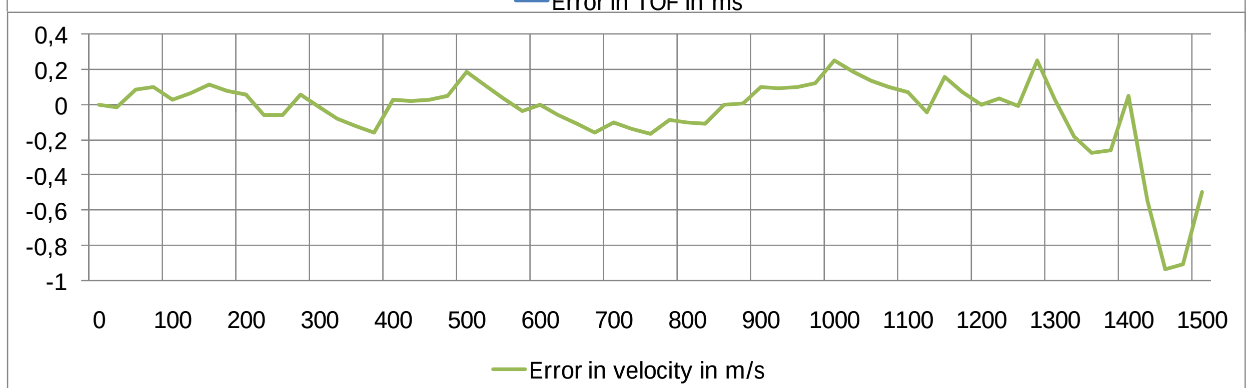
weapon:
M82A1

ammunition:
M8 .50BMG

range:
0 – 1500 m





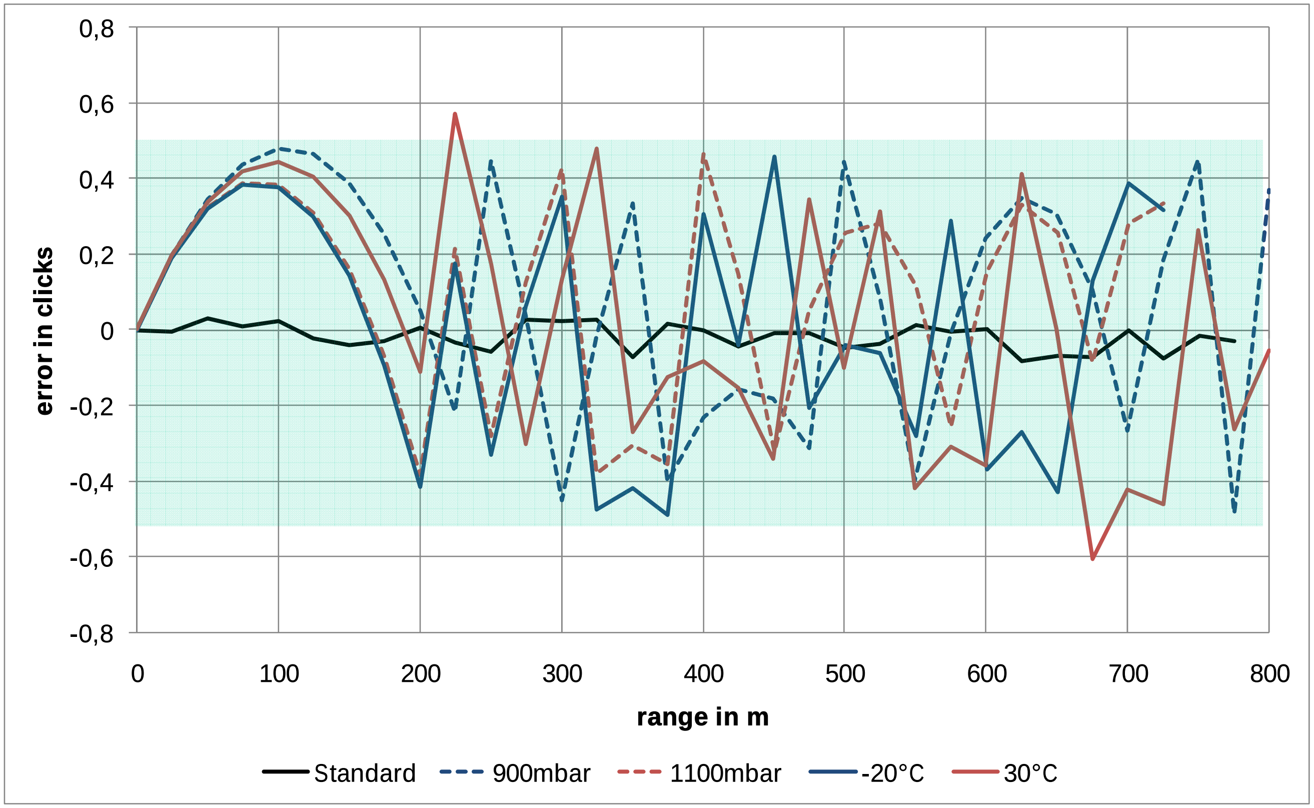


Met Variations

weapon:
HK G3

ammunition:
M80 .308

range:
0 – 800 m

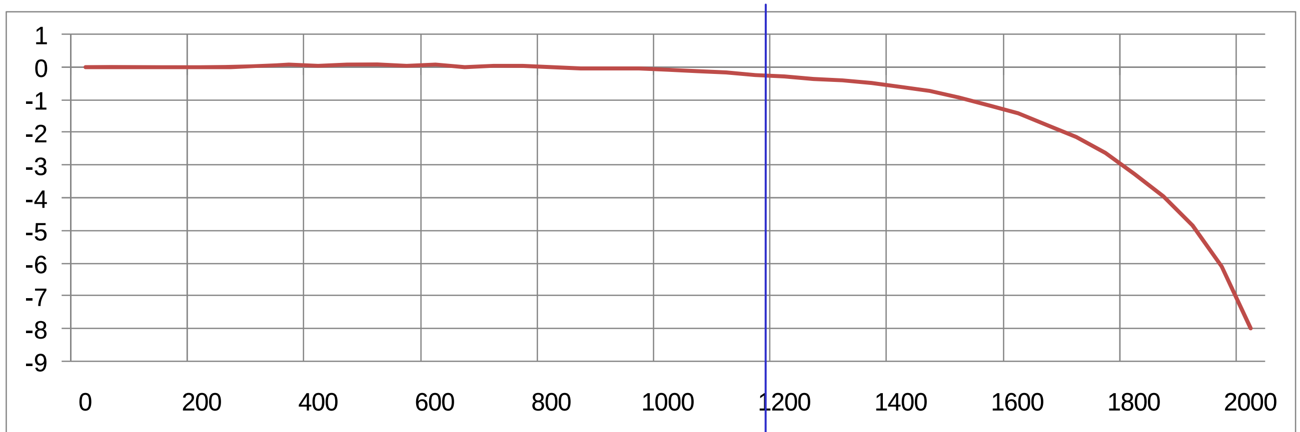


Model Limitations

weapon:
HK GMG

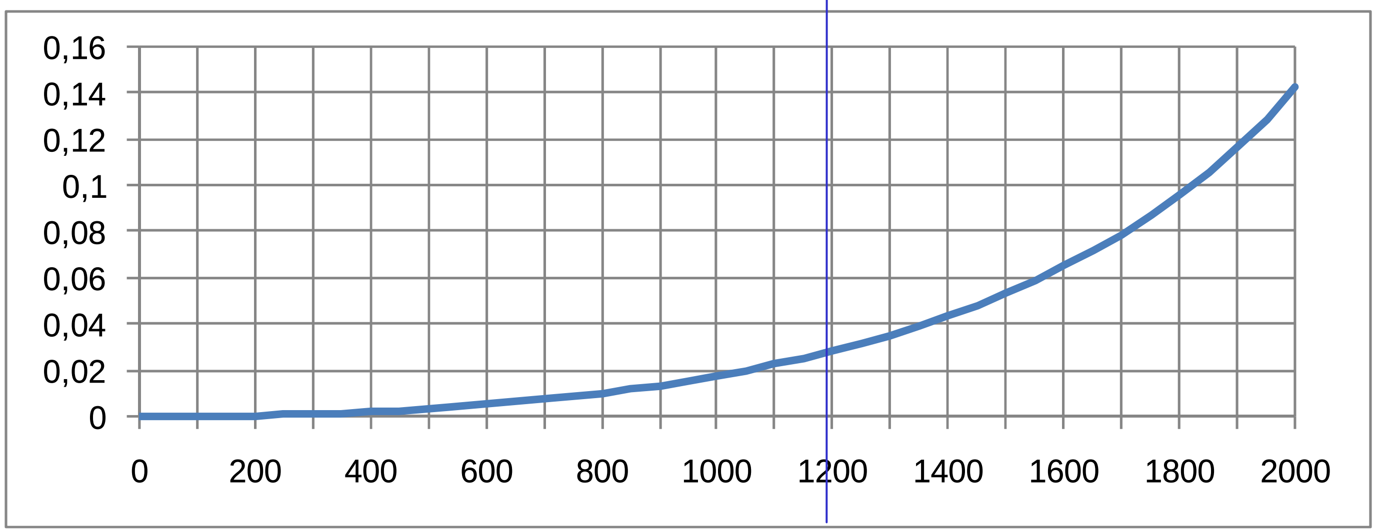
ammunition:
40mm

range:
0 – 2000 m

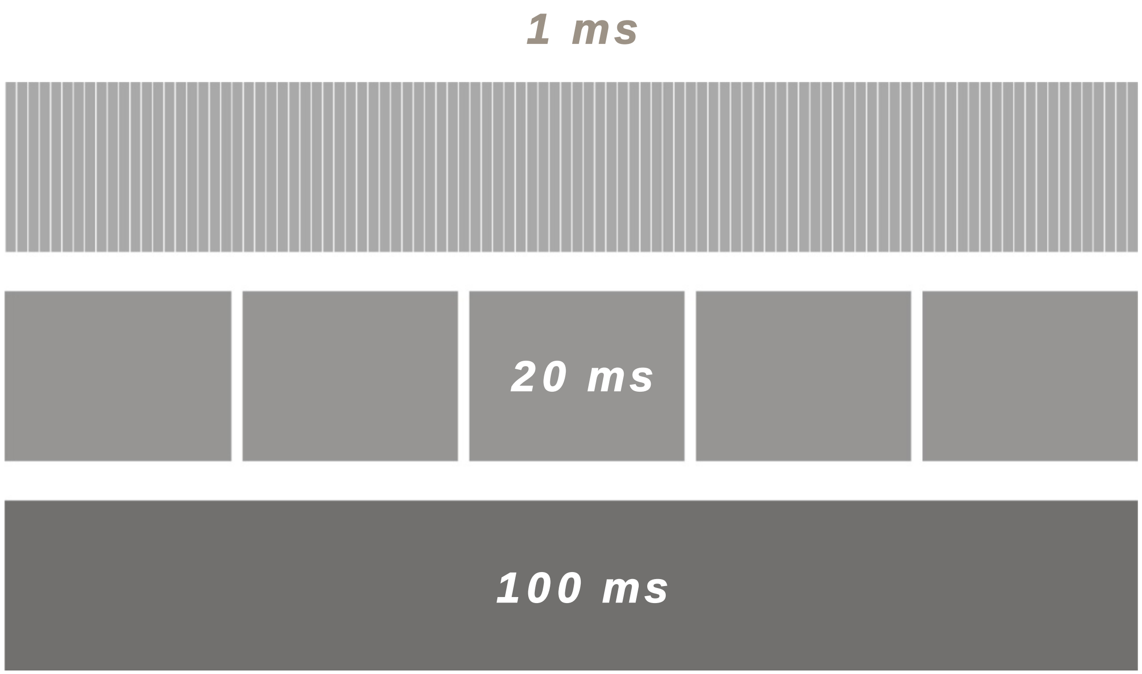


elevation error in mils

flattening R



algorithm usage in an automated fire control system



compute fire control solution

typically 0.1 to 1.2 ms depending on options used

sensor readout

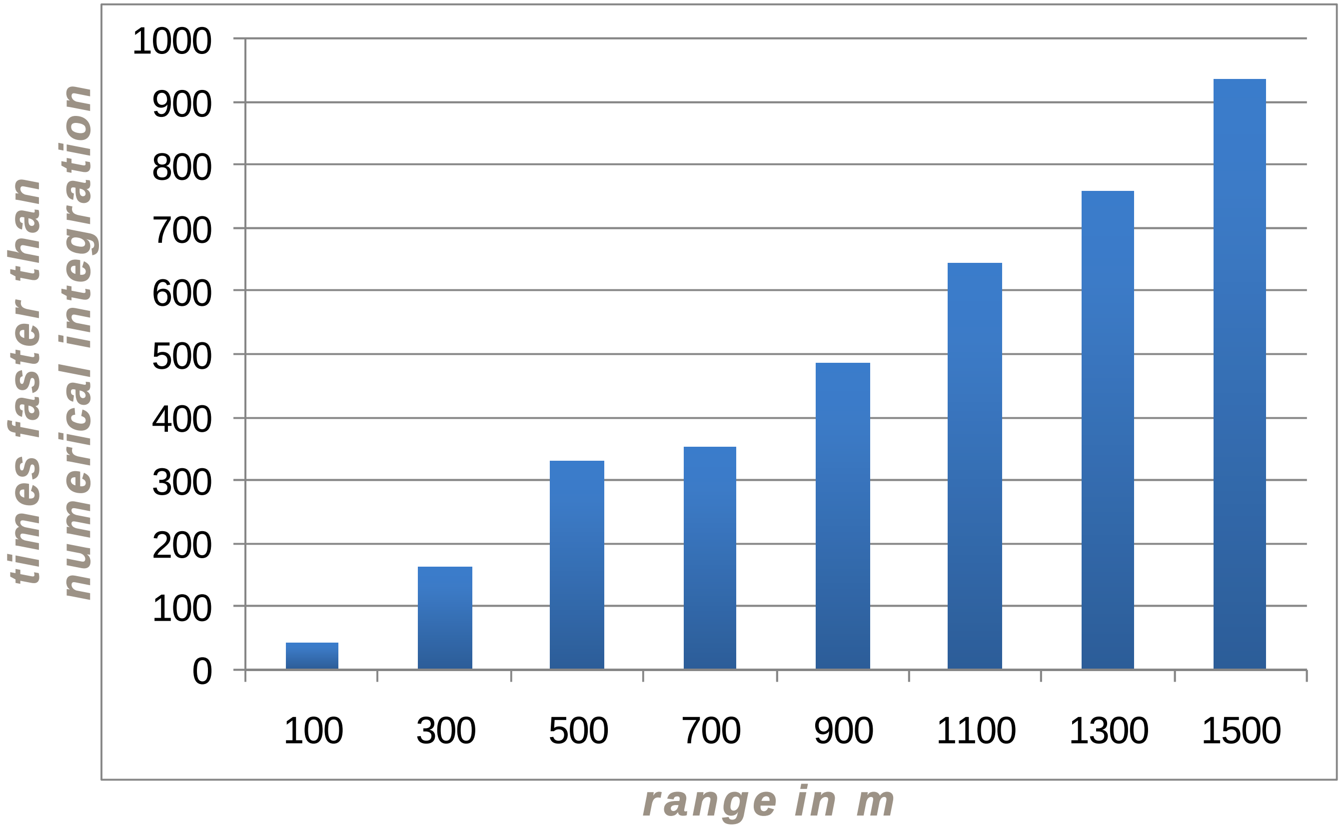
typically every 20 ms

re-align weapon

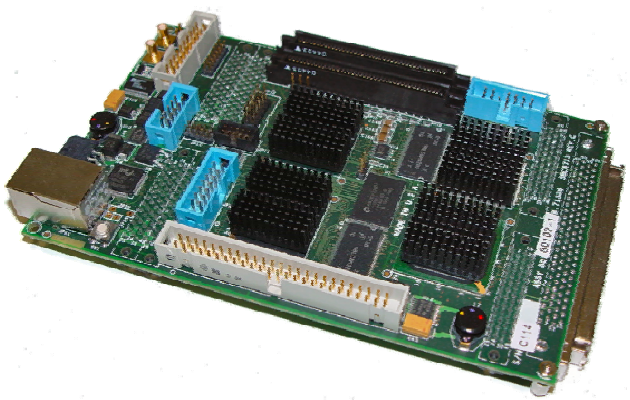
typically 100 to 1000 ms

Performance

Comparing analytical solution with numerical RK4 integration for a .50BMG rifle:



Implementations

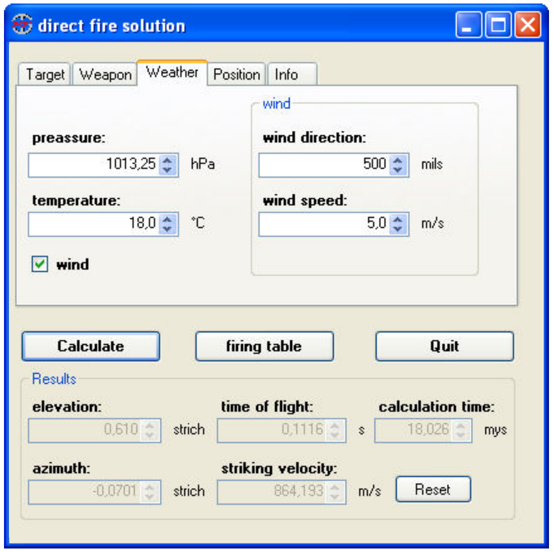


DSP based stand alone fire control computer

Optimized MISRA-C source code compiled for TI DSP system

Pocket PC implementation

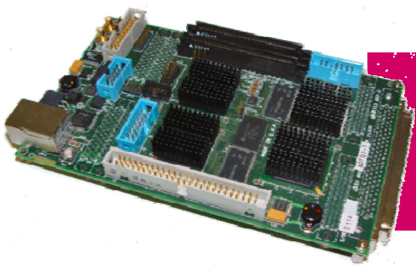
C# source code compiled for MS Pocket PC 2003



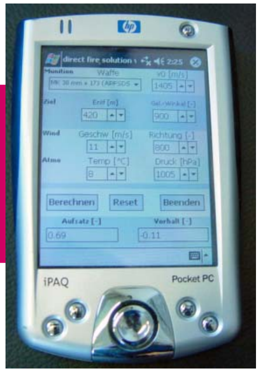
Windows demonstrator front end

C# source code compiled for MS Windows

Implementations



using spare
computational power



using spare
computational power

Conclusions

An analytical solution for the differential equations of motion was found

- *thermodynamic state of the atmosphere was considered*
- *Multi region drag fitting*
- *uphill / downhill shooting*
- *wind / coriolis / spin deflection*

An optimized algorithm was developed

- *Optimized to minimized computation time*
- *Multi weapon / ammunition capabilities*
- *compact code size*
- *approved accuracy under nearly all conditions*

Sample implementations were introduced

- *handheld fire control for sniper teams*
- *in-sight automatic fire control for crew weapons*

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Fire Control Units for Thermal Weapon Sights

H. Rothe, HSU
A.Kuhrt, HSU
R. Breiter, AIM

Chair for Measurement and Information Technology
Univ. Prof. Dr.-Ing. habil. Hendrik Rothe

Agenda

1. Motivation
2. Mathematical model
3. DSP fire control computer
4. Results and experiences
5. RangIR applications
6. Conclusion

Motivation

Past

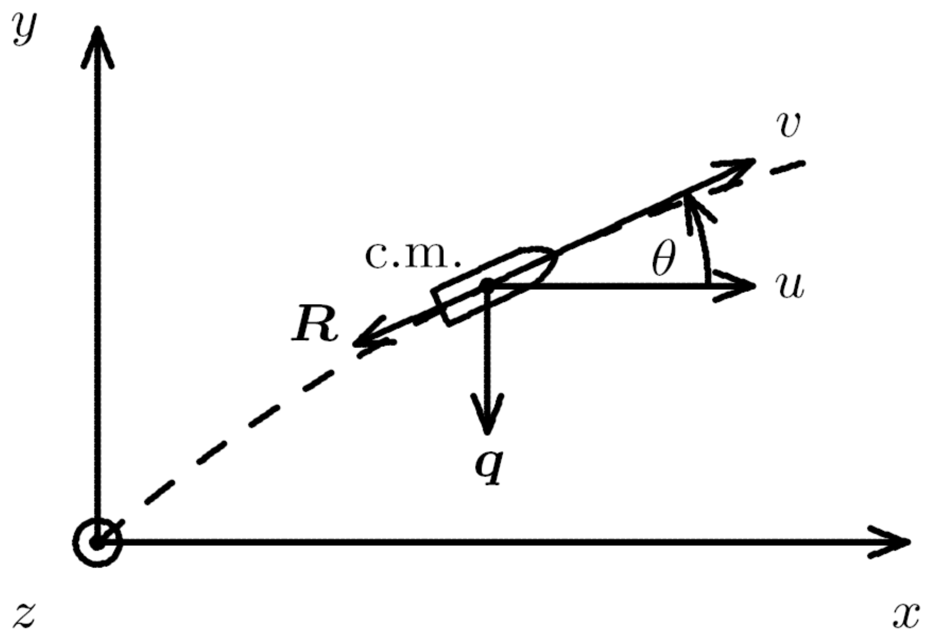
fire control for complex weapon systems

Present

fire control for light supporting weapons


IdZ-ES Equipment: An overview
RHEINMETALL DEFENCE
Recce Equipment
Recce Projectile
Thermal Sight
Weapon Accessory Equipment
Video Visor
Thermal Visor
Core System
Headset
(active, with earprotection)
Core Computer
Battery Pack
(SM-bus compliant)
Navigation System
(GPS + inertial)
Group Radio (UHF)
Control Unit / Auxiliary Display
Cabling
(Warning Sensors)
Helmet System
Digital Magnetic Compass
Helmet with Ballistic Cover
Helmet Display
alternatively:
Night vision Goggles
Commander Equipment
Troup Radio (VHF)
Portable Control Computer (TFR)
Clothing, Protection and Carrying System
- Combat Dress
- NBC - Protection
- Thermal Protection
- Rain Protection
- ball. Protection
- Carrying System
Base Station / Vehicle Adaption
Adaption FüInfoSys / IFIS Group Radio
MIP

mathematical model



$$M\dot{\boldsymbol{v}} = \boldsymbol{q} + \boldsymbol{R}$$

$$\frac{\mathrm{d}u}{\mathrm{d}x} = -\frac{R}{M}\frac{1}{v}\,,$$
$$\frac{\mathrm{d}p}{\mathrm{d}x} = -\frac{g}{u^2}\,,$$
$$\frac{\mathrm{d}y}{\mathrm{d}x} = p\,,$$
$$\frac{\mathrm{d}t}{\mathrm{d}x} = \frac{1}{u}\,.$$

mathematical model

fire control algorithm

- **Point mass model** according to NATO STANAG 4355 Appendix G
- **atmospheric data extrapolation** according NATO STANAG 4044
- **power drag law**
- **Gravity calculation** according to WGS84
- **Coriolis approximation** according to McCoy
- **crosswind considered** by Didion‘s formula
- **spin caused deflection** according to NATO STANAG 4355 Appendix G

mathematical model

fire control algorithm

- Equations of motion transferred to range regime
- numerical solution using RK4 intergration scheme for inital value problem (inner loop)
- boundary value problem solved by secant method (outer loop)
- vacuum solution used as inital value estimator

DSP fire control computer

Sensor based input
- azimuth
- elevation
- cant
- range

fire control algorithm

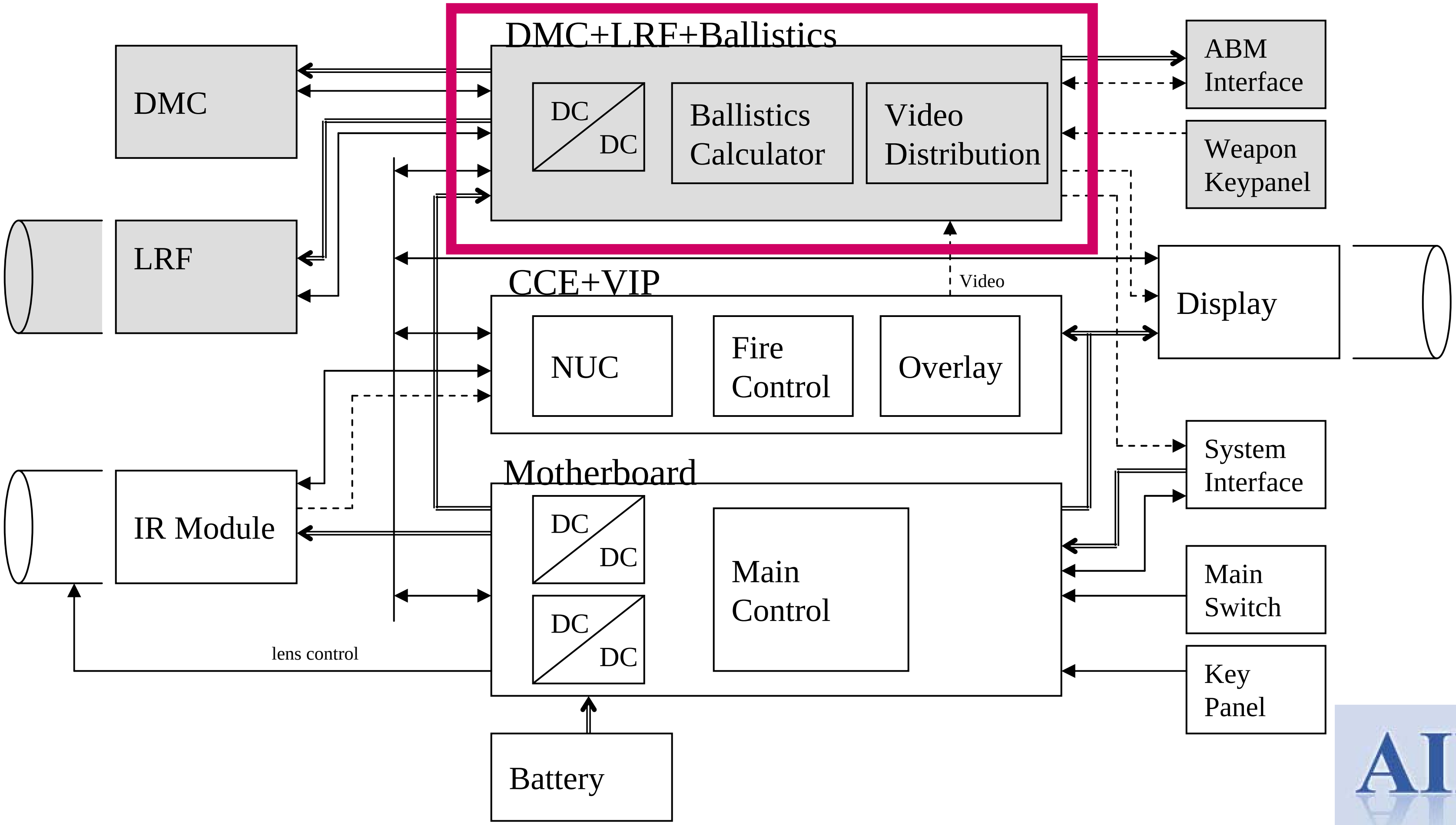
User supplied input
- temperature
- pressure
- wind
- latitude

weapon data output
- time fuze settings
- aiming point

3D digital magnetic compass

Laser range finder

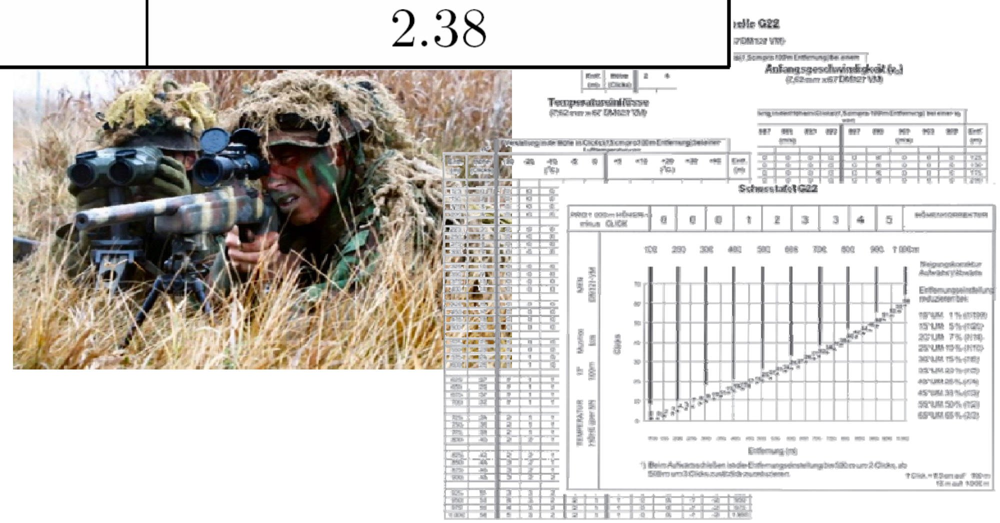
ballistic computer on digital signal processing card



Results and experiences

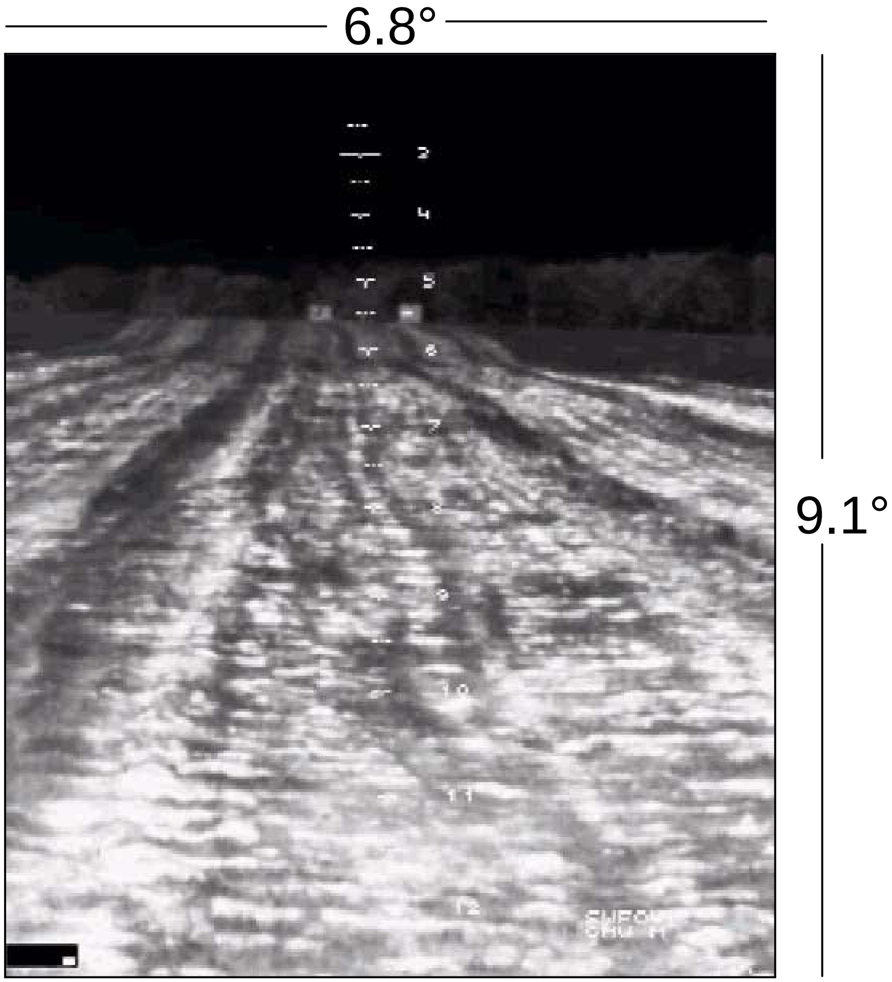
Comparison of the fire control algorithm with ballistic tables

Parameter	Average deviation, %
Elevation	1.13
Time of flight	0.52
Wind, *Coriolis* force, spin	16.05
Height of crest	0.66
Target velocity	0.44
Angle of fall	2.38



Results and experiences

RangIR used as Fire Control Unit for the 40 mm GMG



RangeIR applications

WBZG* for the German IdZ+

HUNTIR ZIELGERÄT FÜR DEN IdZ

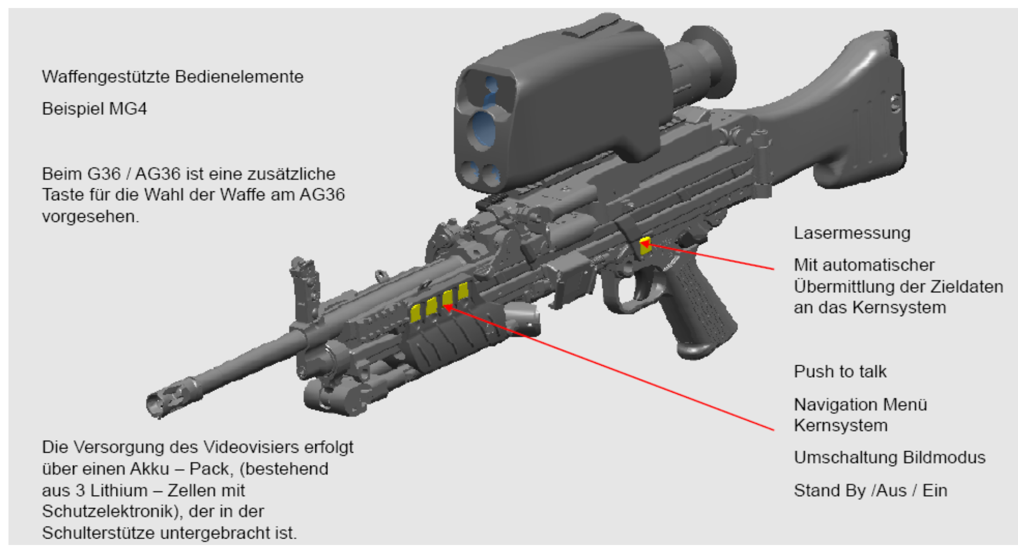
** Infrared sighting mechanism*

+ Infantrymen of the Future

RangeIR applications

RangeIR
with integrated fire
control computer
on cal .50 BMG rifle

RangeIR
with integrated fire
control computer
on 5.56 mm light MG



RangeIR applications

5.56

5.56

7.62

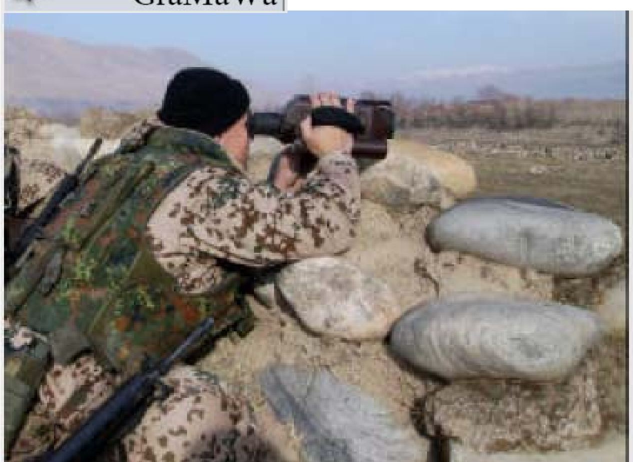
12.70

40.00

range < 1500 m

cal. 5.56 – 40 mm

time fuze option



Conclusions

Improved effectiveness of light supporting weapons

- high first hit probability
- very successful test firings
- part of German project IdZ (Infantrymen of the Future)

Follow-ons

- conformance to MISRA-C and DIN EN ISO 61508
- live firings to test firing uphill and downhill

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RDECOM

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2008 International Infantry & Joint Services Small Arms Systems Symposium

System Analysis: Infantry Studies and Simulations

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Timothy Fargus, Michael Wilson, and Alexander Lee

System Analysis, ARDEC

Timothy.fargus@us.army.mil, michael.c.wilson@us.army.mil, alexander.lee5@us.army.mil

5/21/08

Overview

1. How does System Analysis Modeling and Simulation improve the world of infantry technology and doctrine?
2. Modeling and Simulation tools
3. Examples of analysis performed
4. M&S Outlook

Improving Small Arms through Modeling and Simulation

- **How does System Analysis Modeling and Simulation improve the world of infantry technology and doctrine?**
  - Allows us to QUANTIFY improvements in warfighter survivability, lethality, and mission success by modifying specific parameters (e.g. improved body armor, lighter weapon)
    - Can define optimal technology to accomplish goal
  - Comparison of existing technologies
    - Models and simulations show the effects of these capabilities and allow us to compare these situations to the baseline
      - How does this undeveloped capability improve our forces' lethality, survivability, and ability to accomplish a given mission?
      - Which capability leads to the most improvement? Optimization.
- **Points towards the technology alternative that is closest to goal.**

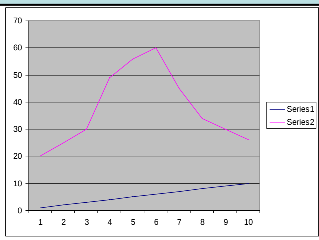
Improving Small Arms through Modeling and Simulation

- M&S is essential throughout the development of a Small Arms technology!
  - Saves money
  - Allows controlled experiments to obtain statistical results
  - Results create direction for development of small arms technology

Improving Small Arms through Modeling and Simulation

RDECOM

Real life test data



Soldier input

Analysis using Software tool(s)

Results and Conclusion

Support for R&D Effort

Development of Small Arms System

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Guidance

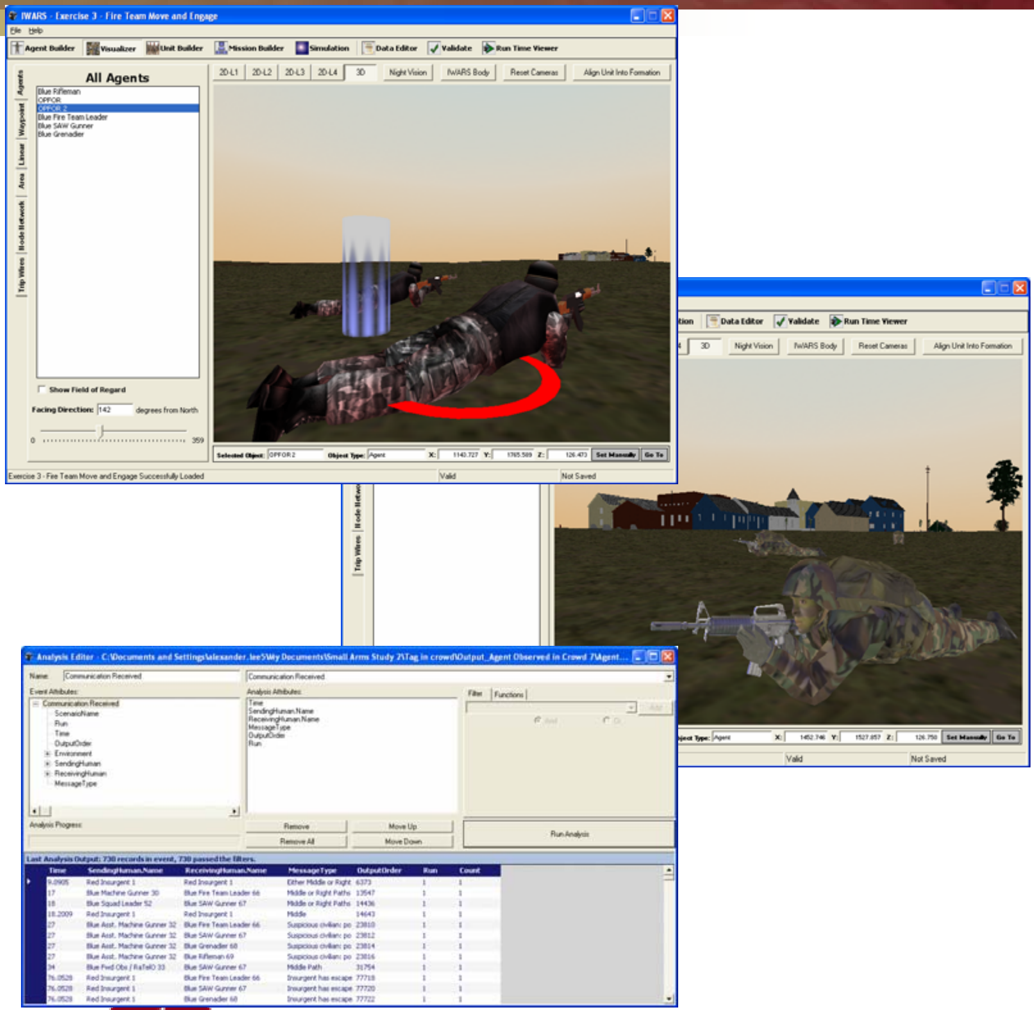
- Guidance from Subject Matter Experts (eg: Infantry School at Ft. Benning)
  - What areas of improvement to study
  - Measures of Effectiveness (MOE's)
  - Infantry scenarios
  - Training Doctrine

- Working in coordination with other efforts to support Army Technology Objectives

- Major Demands:
  - Higher stopping power
  - Better protection
  - Lighter equipment
  - Reduce exposure to fire

- Given this information, what input provides the system with the best performance according to the MOE's?

Tools: IWARS



IWARS (Infantry Warrior Simulation) – AMSAA approved model

- Force-on-Force Analysis
- High resolution Dismounted Infantry model
- Programmable Small Infantry Engagements
- 3-D representation and run time viewer
- Output analysis tool

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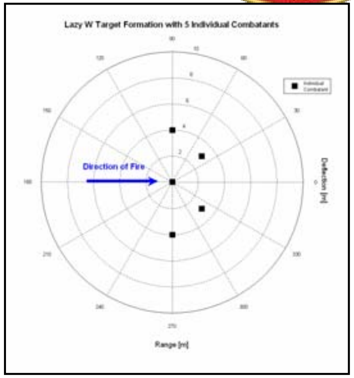
Tools: CASRED and FBAR



Weapon Characteristics
- Fragmentation Data[1]
- Terminal velocity [2]
- Angle of Fall [2]

Delivery Accuracy
- Baseline Case
- Improved Range Finder
- Improved MV
- Improved Range & MV

Target Formation
- 5 combatants
- Lazy W [3]

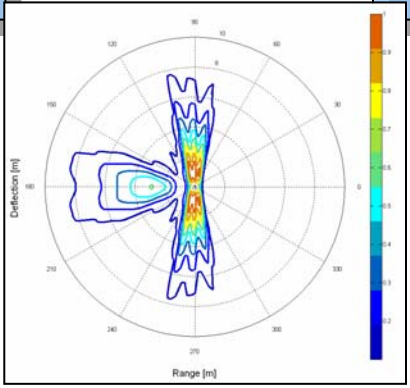
CASRED (Lethality)

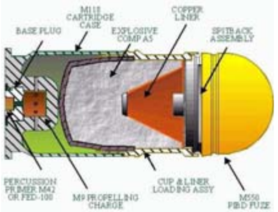
Pk Contour files

FBAR (Effectiveness)
50,000 Monte Carlo Trials

Expected Fractional Casualty Values

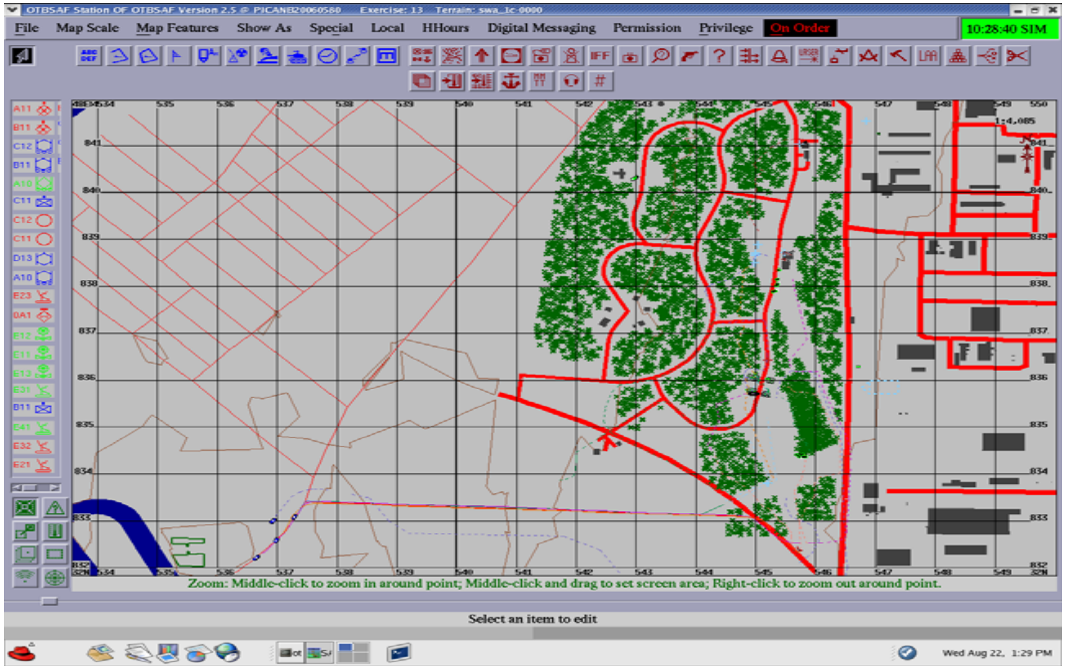
Individual Soldier Data
- Winter Uniform
- No Armor / No Helmet
- Standing Posture
- 5-min Assault Criteria





Allows examination of lethality of theoretical weapon systems in comparison to ones in use today.

Tools: One Saf Test Bed (OTB)



- Distributed force-on-force simulation
  - A macro perspective allows large force-on-force engagements
  - Shows what technology can do under operation conditions

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Infantry School Guided Study 1

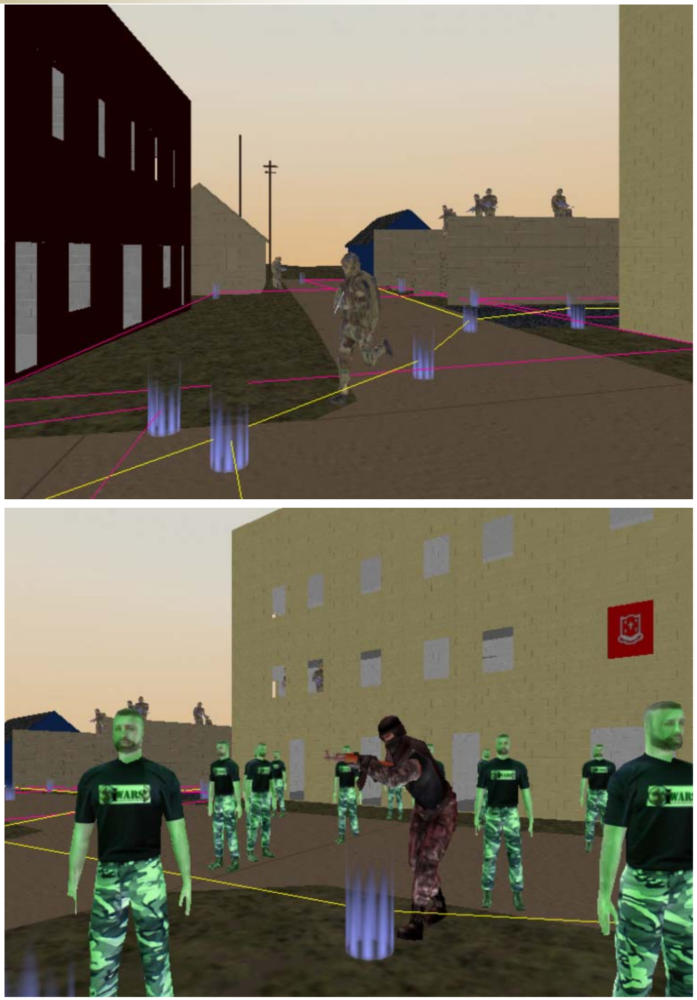
• In baseline scenario, breaching squad is exposed in street waiting for door to be breached

• Breach takes approximately 5 seconds

•With improved capability, the breaching round is fired from cover while the breaching squad waits under cover

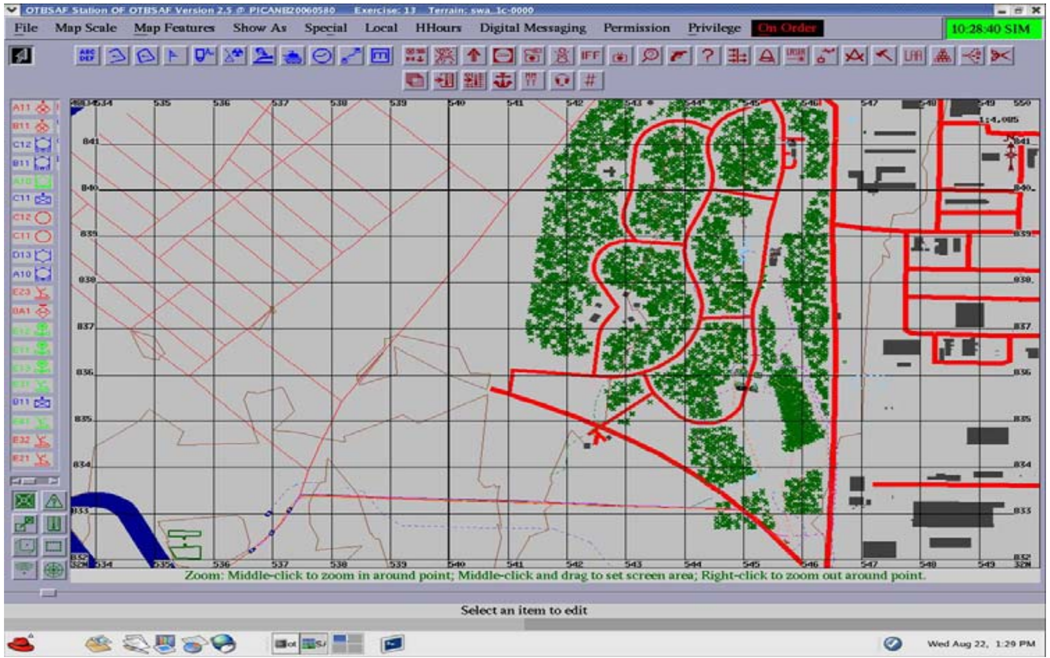
•Answers the question: How much improvement in terms of friendly force survivability and breaching time can be achieved using a breaching round?

Infantry School Guided Study 2



- If potential insurgent can be tagged, he can be pursued more effectively.
- Allows the warfighter to discriminate the target from other civilians.
- Higher percentage of correctly locating the target = better tagging technology.
- Marginal improvements in capture times and success rate were recorded
- Results show most return with 100% accuracy for tagging.

OTB work



- Scenario: Blue forces are engaged by red (insurgents) at a roadblock
- Parameter focus is on the Vertical and Horizontal Per-Shot Error of M16.
- Statistics were obtained from 150 runs of the scenario with 30 runs of each parameter modification
- Identified a specific reduction in Vertical and Horizontal Per-Shot error in mils that led to the most the most improvement

Infantry Study Outlook

- Continue to support the development of improvements (materiel or otherwise) to support the warfighter.
- Help to optimize R&D efforts to bring the most benefit to the warfighter.
- Continue to implement new tools to expand our effort.

Aimpoint BR8

A Fire Control System for Small Arms

Aimpoint

THE FUTURE IN SIGHT

Reasons for missing the target

External influence
(e.g. ballistical trajectory, wind speed and direction, temperature)

Weapon System
(e.g. dispersion)

Time
(e.g. duration for operation of weapon system)

P_{hit}

Target
(e.g. visibility, motion)

Operator influence
(e.g. shooting position, estimation of distance to target, breathing, aiming, trigger control)

Most important influence

- Operator
- Distance to target together with ballistic trajectory

Mechanical solution — MPS3

- 4 MOA red dot
- 8 NVD settings and
  8 daylight settings
- 70,000 hours of operation
  (on setting 12 of 16)
  on a single battery
- AA 1.5 V alkaline battery
  (sight accepts voltage up to 5.0 V)
- Prepared for external picatinny rail
- MIL-STD 1913 MGMount includes 3-step ballistic compensator (200,800 and 1200m)

MPS3 and MGM

- MIL-STD 1913 MGMount includes 3-step ballistic compensator (200,800 and 1200m – option customized)

1200m

Aimpoint

In operative use with US Forces

Swedish FCS development

- Trials with AGL’s with different FCS’s, and a market study have shown that currently there is no simple, lightweight, robust and affordable FCS available.
- Sweden has therefore decided to develop a FCS with industry for use with underslung grenade launchers, AGL’s and 84mm Carl Gustaf recoilless rifles.
- A PDF study was done in 2002.
- A development contract was placed with Aimpoint in 2005.
- Delivery of prototypes in 2007.

Aimpoint BR8 - Background

- Fully integrated Sight and Fire Control System
- Suitable for a variety of weapons where ballistical correction to improve range performance and P_{Hit}/P_{Kill} is essential
- Prepare system for additional functionalities as technology matures

Aimpoint

THE FUTURE IN SIGHT

Potential

- A very large number of grenade launchers with very poor sight systems are in operative use (M203, AG36, XM320….)

- A large number of Automatic Grenade Launchers are in operative use (Mk 19, Mk47, GMG…..)
- A large number of Heavy Machine Guns are in operative use (M2, M3……)
- A substantial number of Infantry Support Weapons are in use (Carl Gustaf…..)

THE FUTURE IN SIGHT

Crew served, in service

Mk47 with LVS

+ Can do everything anytime
- Expensive, poor batterylife
- Requires a lot of training
- Heavy

Crew served, in service

Mk47 with IS 2000

+ Easy to use
+/- Small for CS,Big for HH
- Moving parts

Hand held, almost in service

OICW with optronic sight

+ Can do everything, anytime
+ 24h system
- Expensive, poor batterylife
- Small FOV = short range

THE FUTURE IN SIGHT

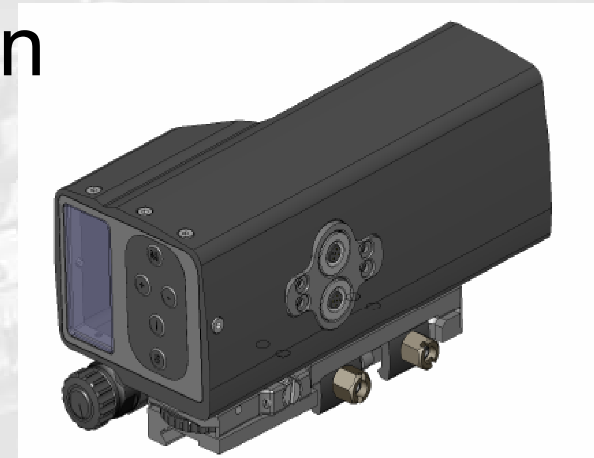
Hand held, almost in service

LEDs indicates correct elevation

Soldato futura, separate FCS

\+ Low cost
-Eyes on sight, not on target
-No real night capability
-No possibility to correct fire

Aimpoint BR8 – System



- 1x optical magnification
- 2MOA dot size
- Unlimited eye relief
- 1,2 kg
- 600 m measurement distance
- MIL-STD 1913 (Picatinny rail) interface
- Rechargeable internal battery
- AA size back-up battery

Aimpoint BR8 – NATO Demo

THE FUTURE IN SIGHT

Aimpoint BR8 – NATO Demo

THE FUTURE IN SIGHT

Aimpoint BR8 – NATO Demo

Aimpoint BR8 – NATO Demo

THE FUTURE IN SIGHT

How it works

V_0*ToF…

1. Aim and measure range

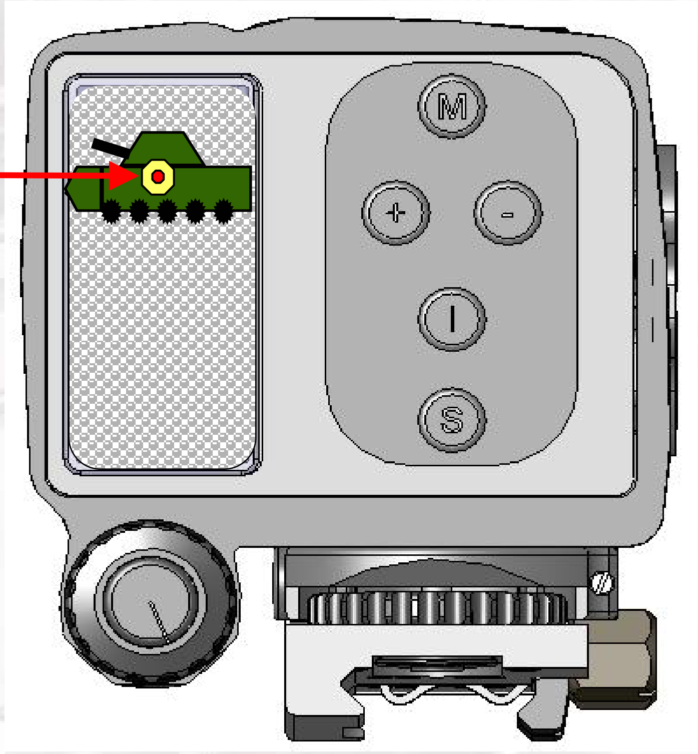
2. Realign and shoot

THE FUTURE IN SIGHT

Man-Machine Interface

Red dot

- Red dot Sight zeroed for the assault weapon
- Zeroed to the lobe of the LRF

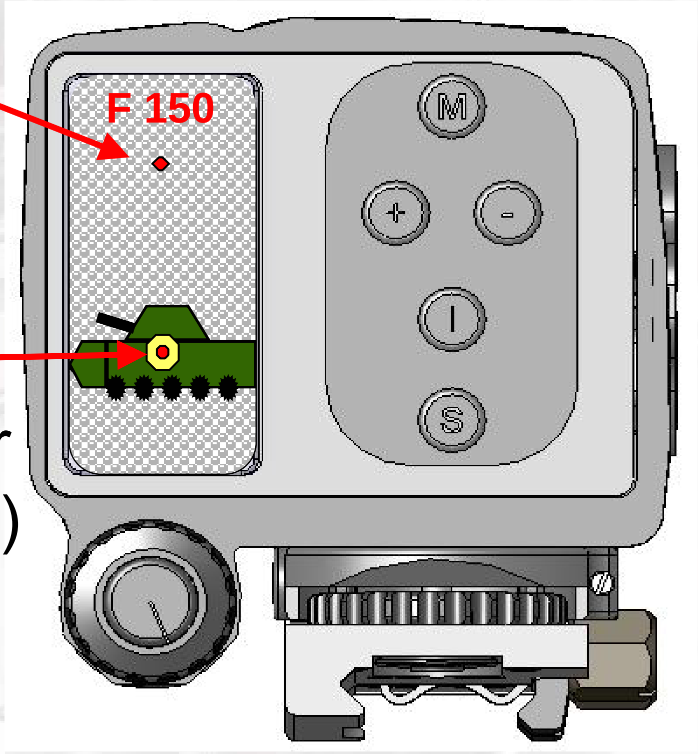


Man-Machine Interface

Possibility to make a new LRF measurement

Possibility to use assault weapon

Blinking Red Dot presented as aimpoint for 40mm UGL (superelevation)



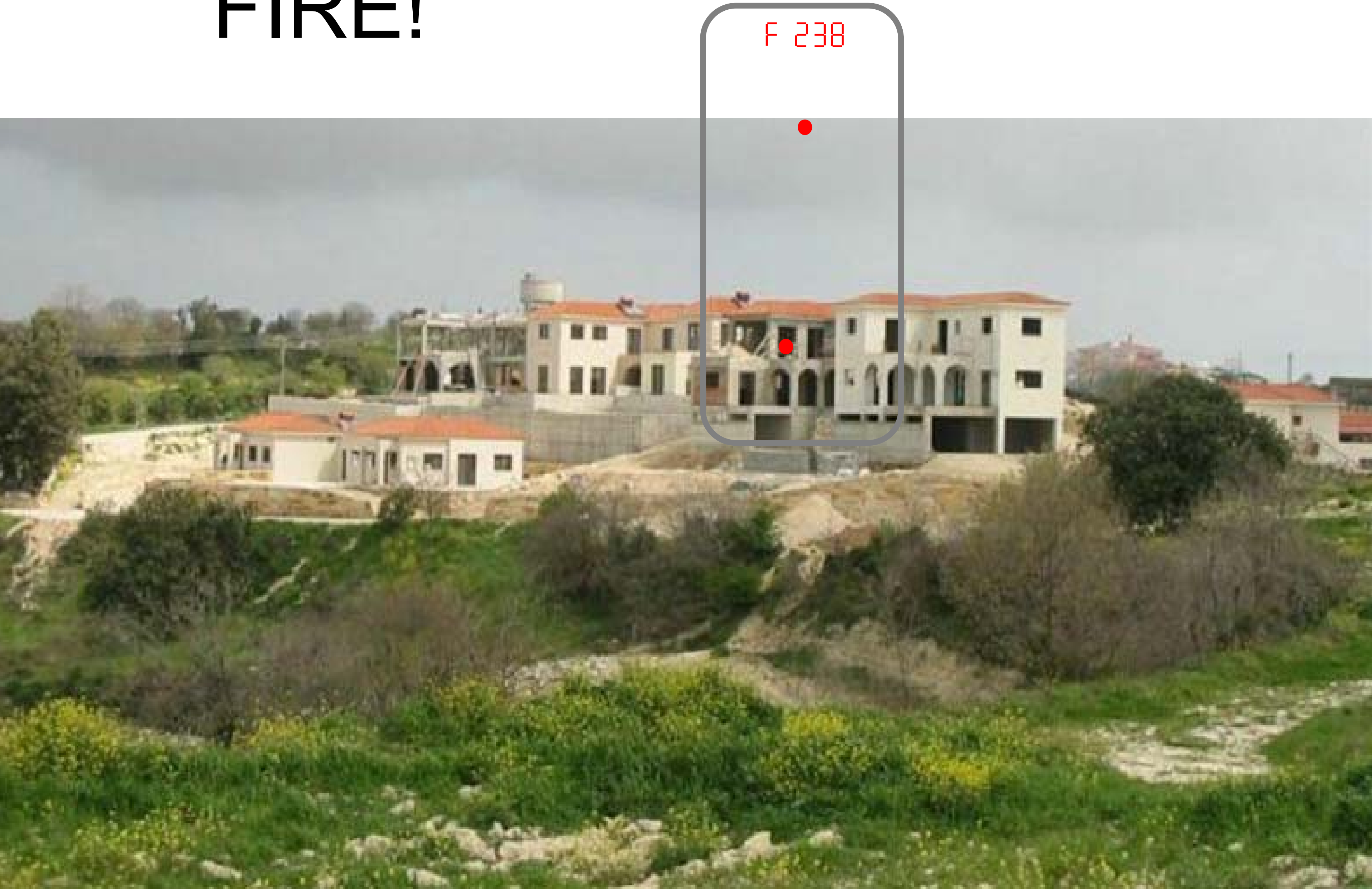
THE FUTURE IN SIGHT

Find your target

Aim at target – Measure Range

Blinking Red Dot - Superelevate

FIRE!



Aimpoint BR8 – Project status

- Prototypes have been delivered to FMV (Swedish Defence Materiel Administration)
- Demonstrated for NATO in Toledo 2007-02-15: > 65% P_{Hit} at 1.2x1.2m targets from 100 to 250m!
- Additional prototypes available in late 2008

WHAT DOES THE USER GET?

- Superior situational awareness

WHAT DOES THE USER GET?

- Superior situational awareness
- Fastest target acquisition
- User friendly and reliable
- Dawn and dusk capability
- Compatible with all generations of NVG
- Long battery life
- Dramatic increase in P_{Hit}
- Increased lethality to the enemy and increased survivability to own troops
- Reduced training time and costs

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TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Effects of Small Caliber Munitions Through Intermediate Barriers

May 2008

Jeremy Lucid – US Army - ARDEC

Introduction

- Can fielded ammunition meet the Needs of the war fighter?
- How well do 5.56mm projectiles penetrate automobiles?
- What are the penetration capabilities of small caliber ammunition against intermediate barriers?

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Typical Intermediate Barriers

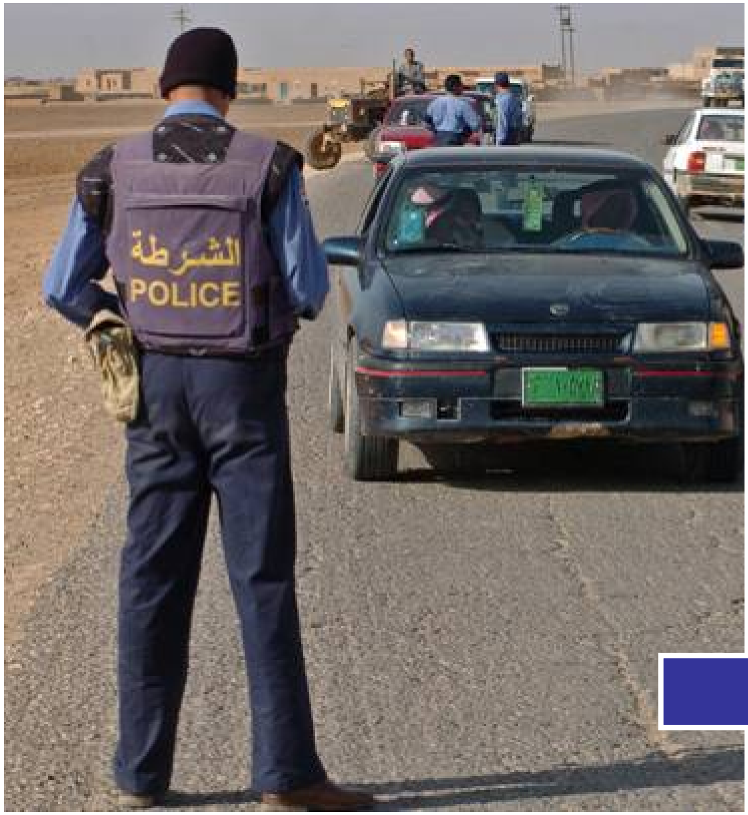
Concrete Wall

Insurgent Vehicle

This vehicle ran a checkpoint.
Could this have been prevented?

Reality ➔ Model

Vehicle Checkpoint



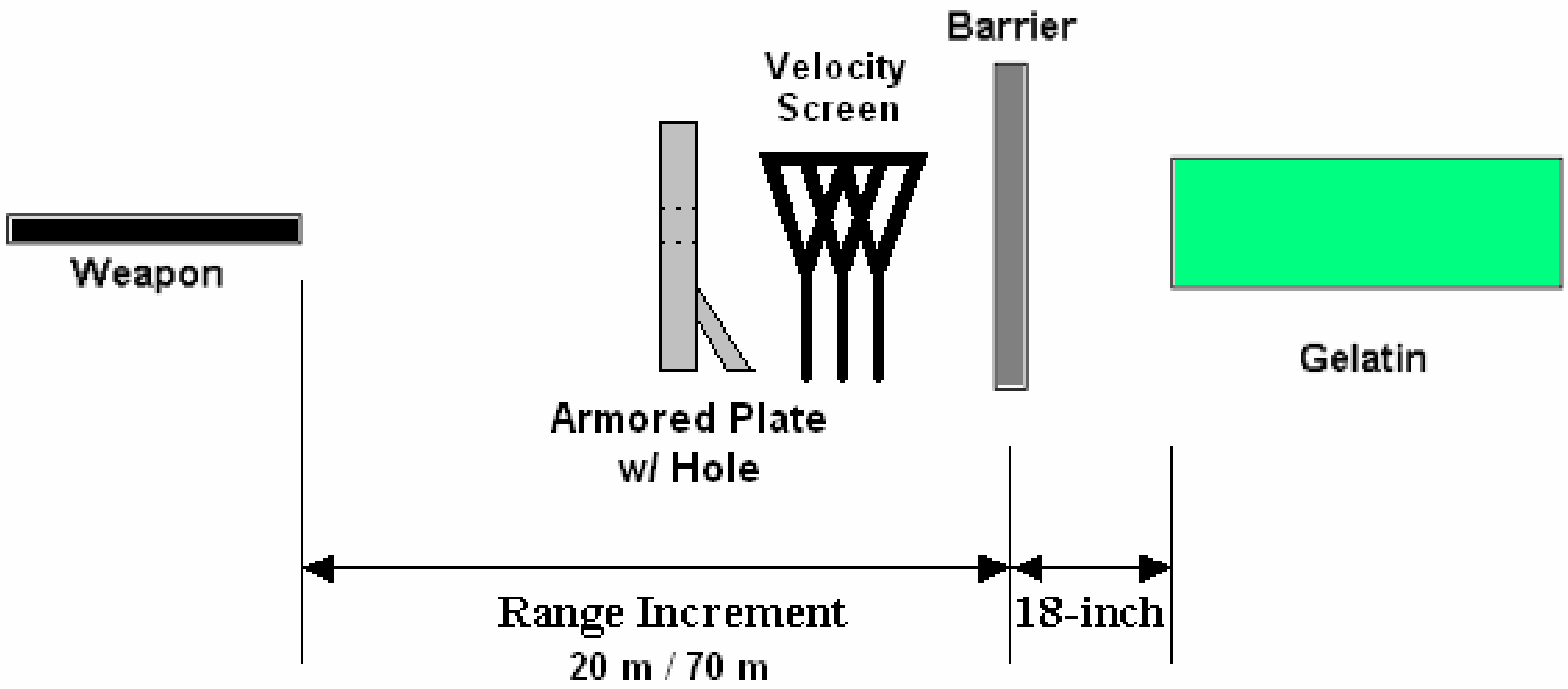
Lab Setup

Phase I – Shot Matrix

<table>
<tr><th>Weapons →
<u>Ammunition</u></th><th>M16 (5.56mm)</th><th>M4 (5.56mm)</th><th>M240 (7.62mm)</th></tr>
<tr><td>M193 (5.56mm)</td><td colspan="3" rowspan="4"><u>Intermediate Barriers</u>

• No Barrier (Baseline)
• Windshields
• Simulated Car Doors</td></tr>
<tr><td>M855 (5.56mm)</td></tr>
<tr><td>MK262 (5.56mm)</td></tr>
<tr><td>M80 (7.62mm)</td></tr>
</table>

Phase I – Range Setup



Phase I – Barrier Setup

90° Steel Plates

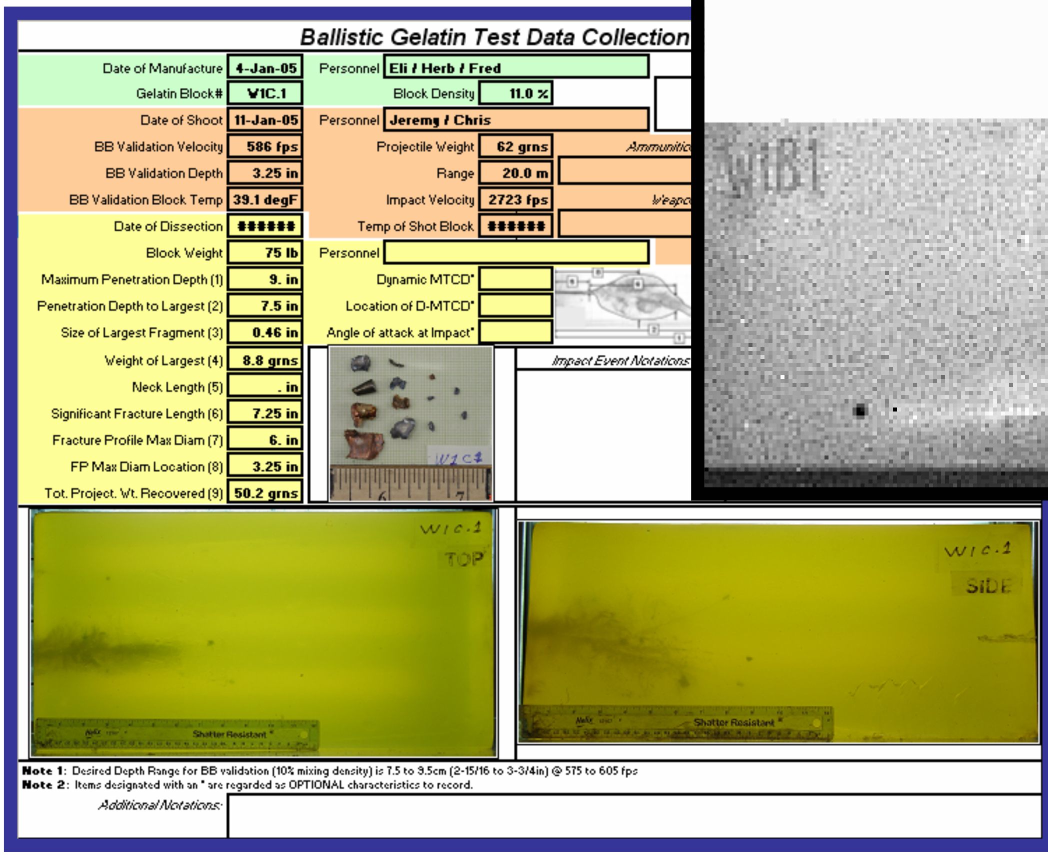
45° Steel Plates

Phase I – Barrier Setup

90˚ Windshield

45˚ Windshield

Phase I – Data Extraction



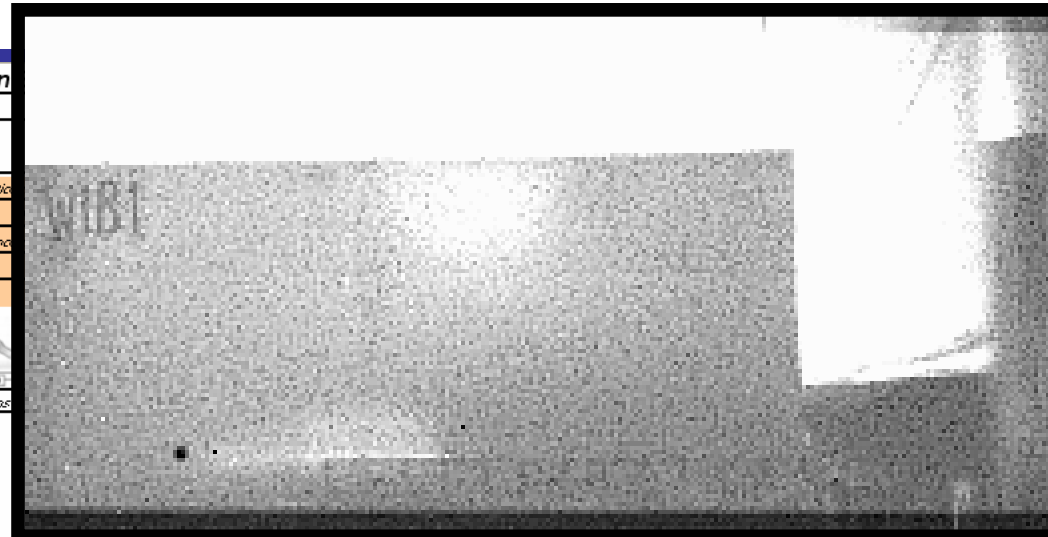
Ballistic Gelatin Test Data Collection

Date of Manufacture	4-Jan-05	Personnel	Eli / Herb / Fred
Gelatin Block#	W1C.1	Block Density	11.0 %
Date of Shoot	11-Jan-05	Personnel	Jeremy / Chris
BB Validation Velocity	586 fps	Projectile Weight	62 grns
BB Validation Depth	3.25 in	Range	20.0 m
BB Validation Block Temp	39.1 degF	Impact Velocity	2723 fps
Date of Dissection	######	Temp of Shot Block	######
Block Weight	75 lb	Personnel	
Maximum Penetration Depth (1)	9. in	Dynamic MTCD*	
Penetration Depth to Largest (2)	7.5 in	Location of D-MTCD*	
Size of Largest Fragment (3)	0.46 in	Angle of attack at Impact*	
Weight of Largest (4)	8.8 grns		
Neck Length (5)	. in		
Significant Fracture Length (6)	7.25 in		
Fracture Profile Max Diam (7)	6. in		
FP Max Diam Location (8)	3.25 in		
Tot. Project. Wt. Recovered (9)	50.2 grns		

Impact Event Notations:

Note 1: Desired Depth Range for BB validation (10% mixing density) is 7.5 to 9.5cm (2-15/16 to 3-3/4in) @ 575 to 605 fps
Note 2: Items designated with an * are regarded as OPTIONAL characteristics to record.

Additional Notations:



- **Recovered Projectile Parameters**
- **High Speed Video**
- **Gelatin Damage Parameters**

Phase I – EDR Analysis

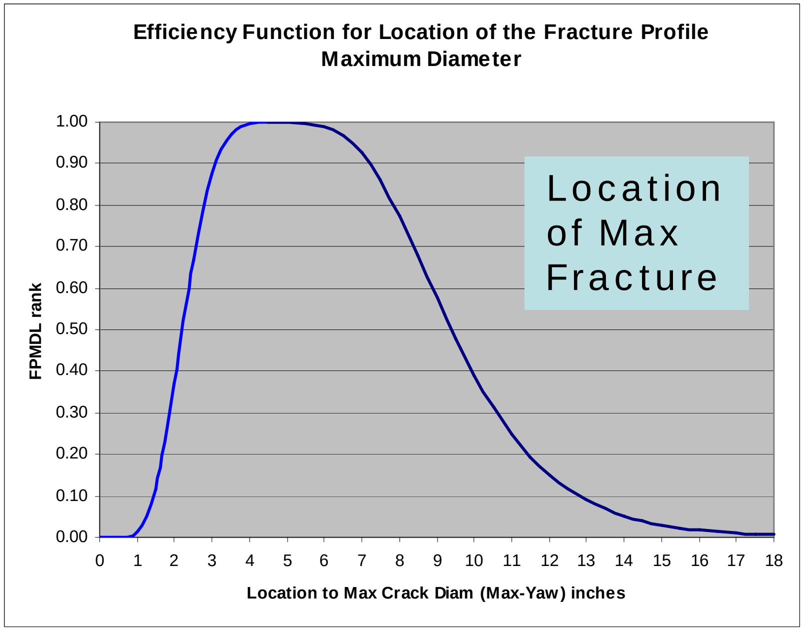
- Effective Damage Rating (EDR) is an abbreviated ranking system designed to quickly estimate the terminal performance of small caliber ammunition against human threats.
- Methodology is defined in Technical Report ARAET-TR-06013

Phase I – EDR Analysis

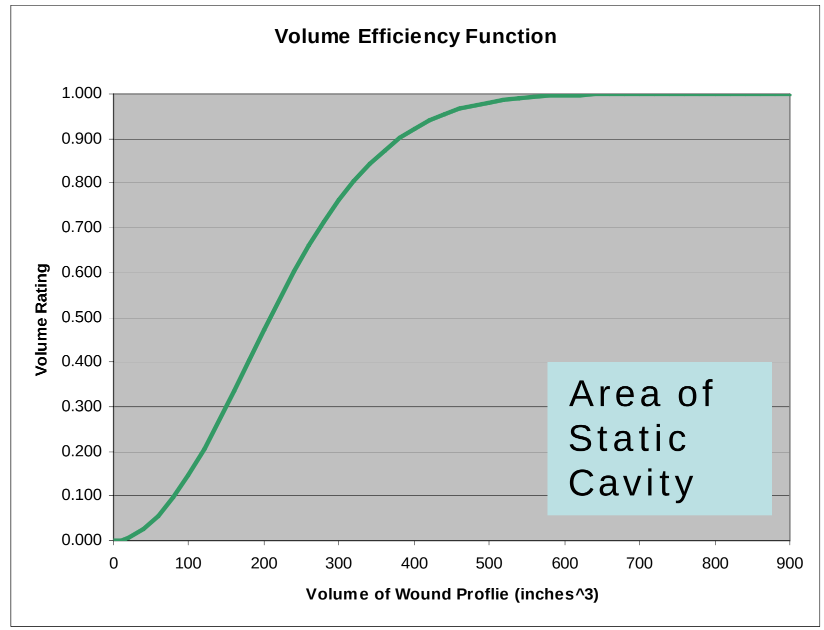
- EDR values range from zero to one
  - (1) One is Good
  - (0) Zero is Bad
- EDR is an average of four rankings
  - EDR-1 *Rapid Effects/ Location of Damage*
  - EDR-2 *Quantity of Potential Damage*
  - *EDR-3 Adequate Penetration*
  - *EDR-4 Potential Engagements of Vital Organs*

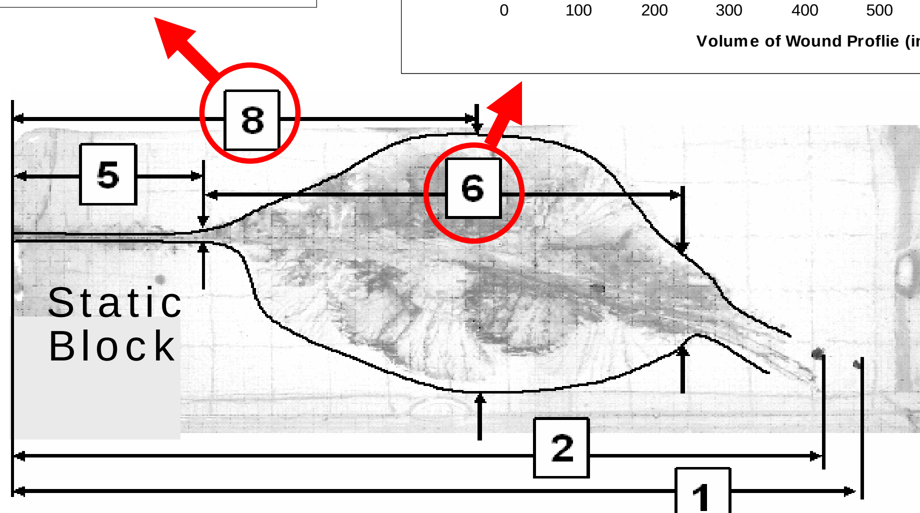
Phase I – EDR Analysis

EDR-1 *Rapid Effects/ Location of Damage* → **25%**



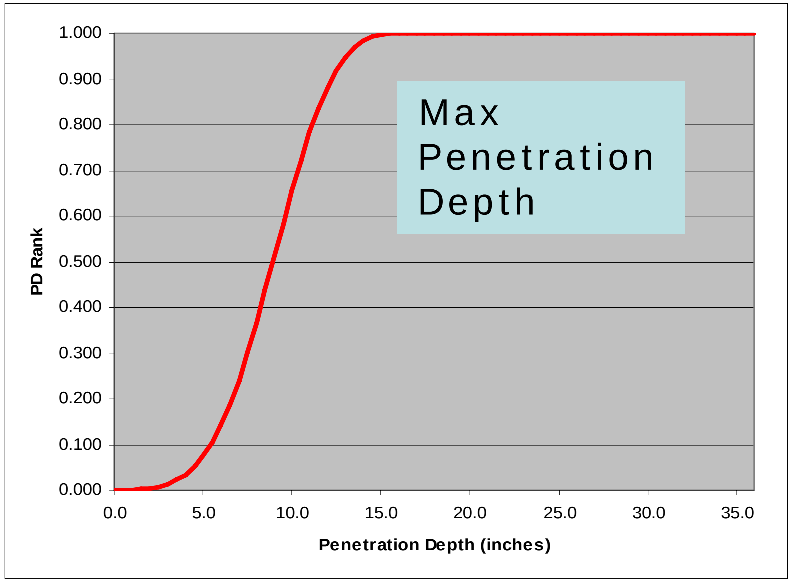
EDR-2 *Quantity of Potential Damage* → **25%**



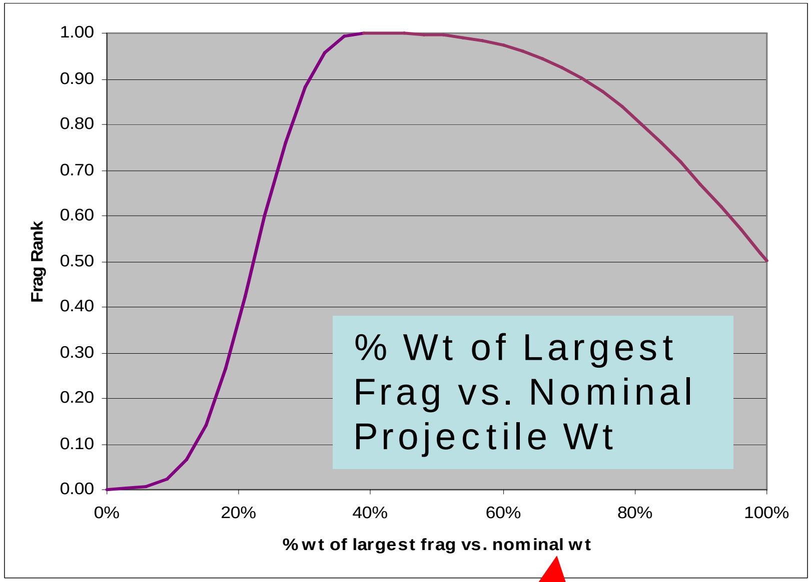


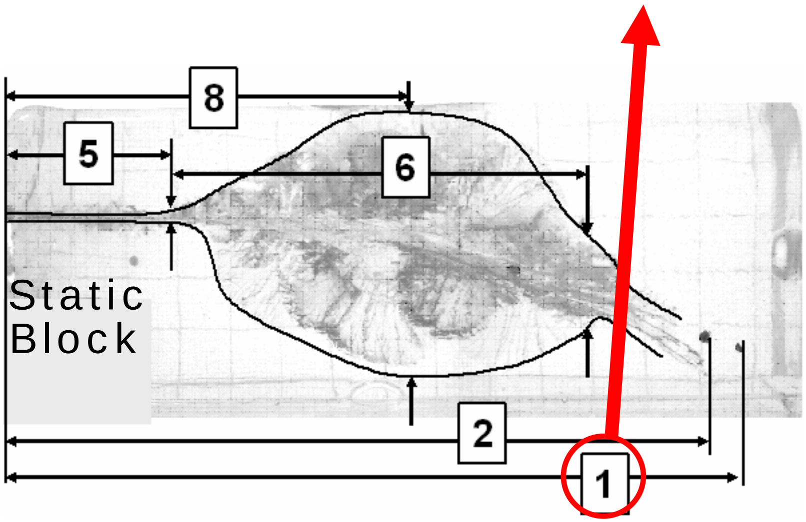
Phase I – EDR Analysis

EDR-3 Adequate Penetration → **25%**



EDR-4 Potential Engagements of Vital Organs → **25%**



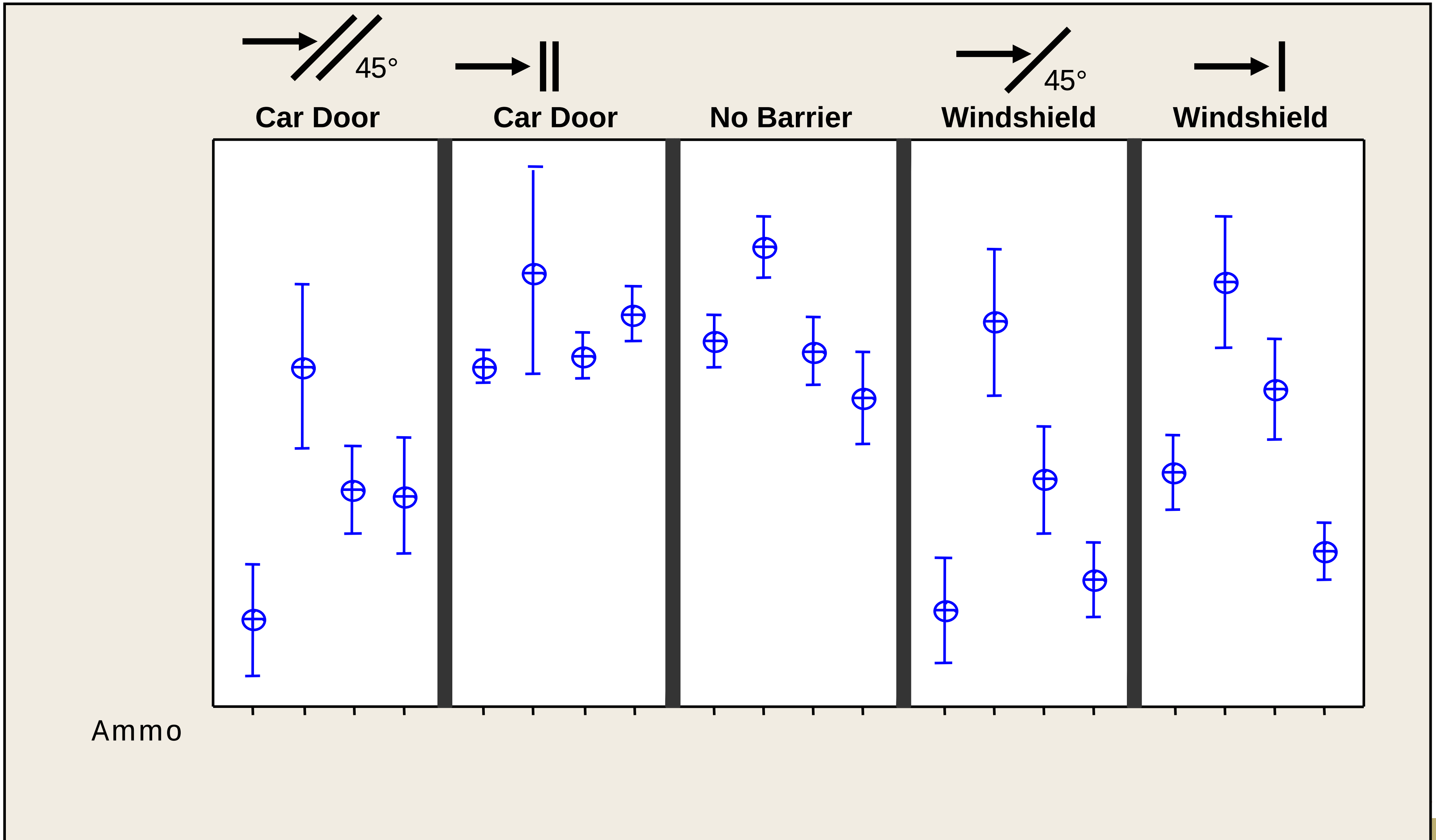


Bullet Fragments

Phase I – Results

Average XYZ (Range: 20 m - 70 m)

95% CI for the Mean



Phase II - Overview

- Evaluate terminal effects of 1,600 rounds of 5.56mm & 7.62mm ammunition through:
  - Automobile windshields at steeper angles
  - Simulated truck doors w/ increased shell thickness
  - Concrete blocks
- Establish quick go/no gages for intermediate barriers to assist in assessing the threat

Phase II - Test Setup

Weapons:

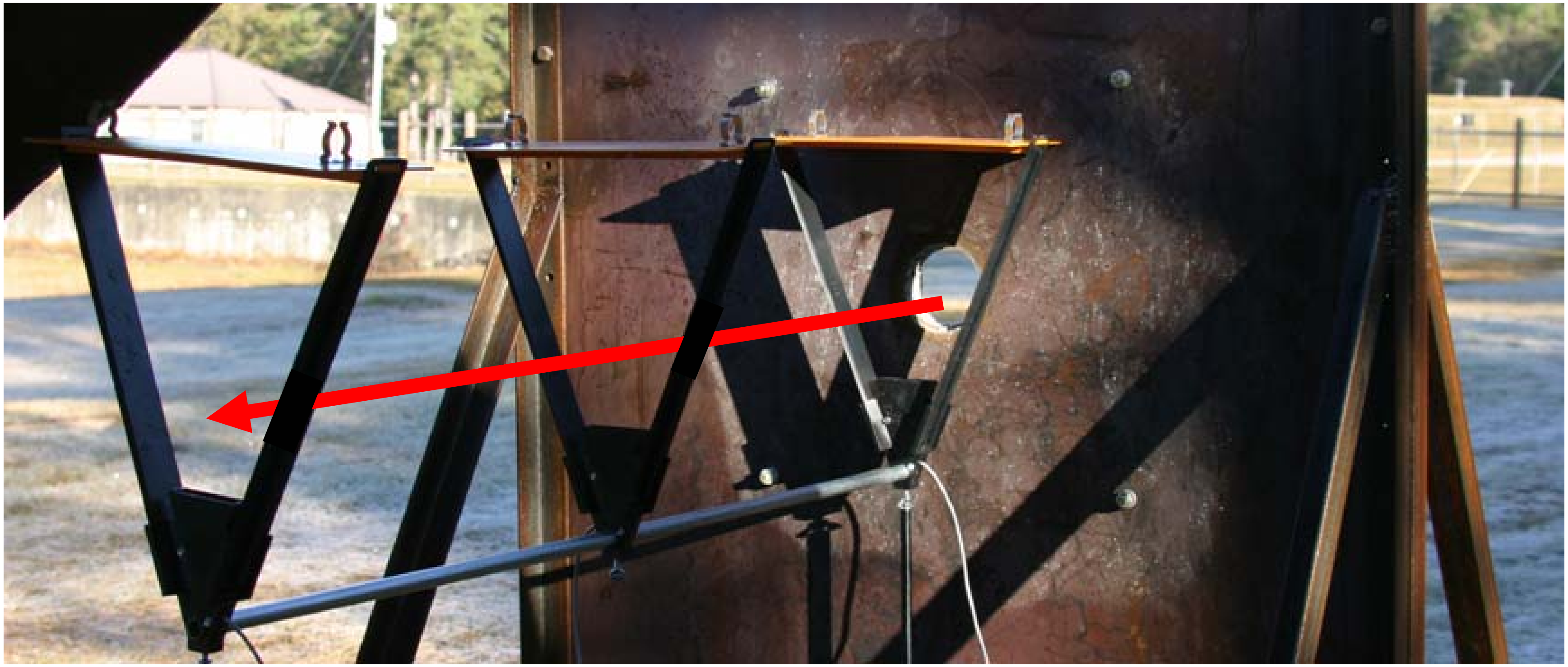
- M4
- M16
- M249
- M24
- M240

Ranges:

- 75m
- 200m

Phase II - Test Setup

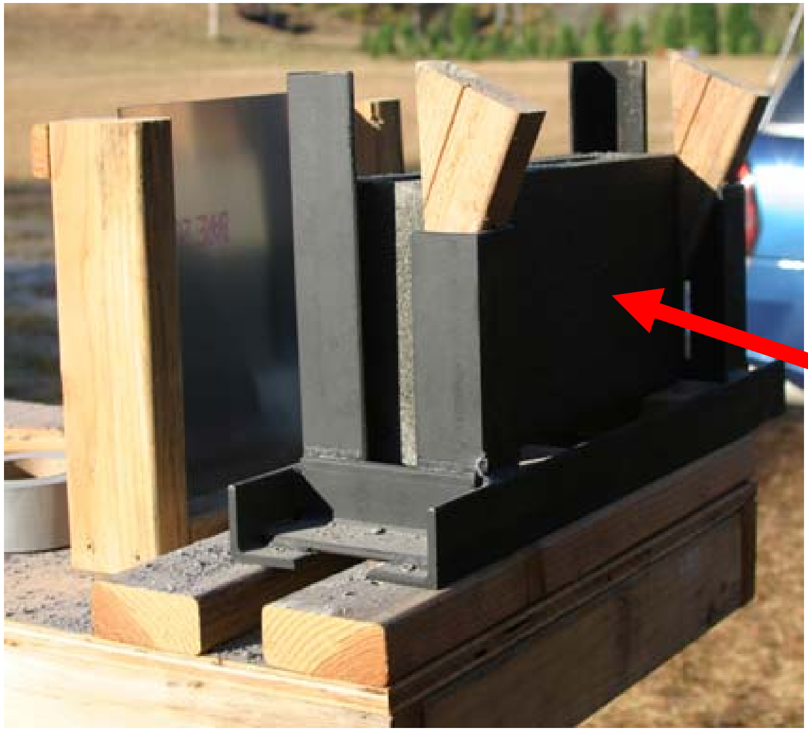
5.56mm Ammo	7.62mm Ammo
M193 M855 MK262 M995	M118LR M80

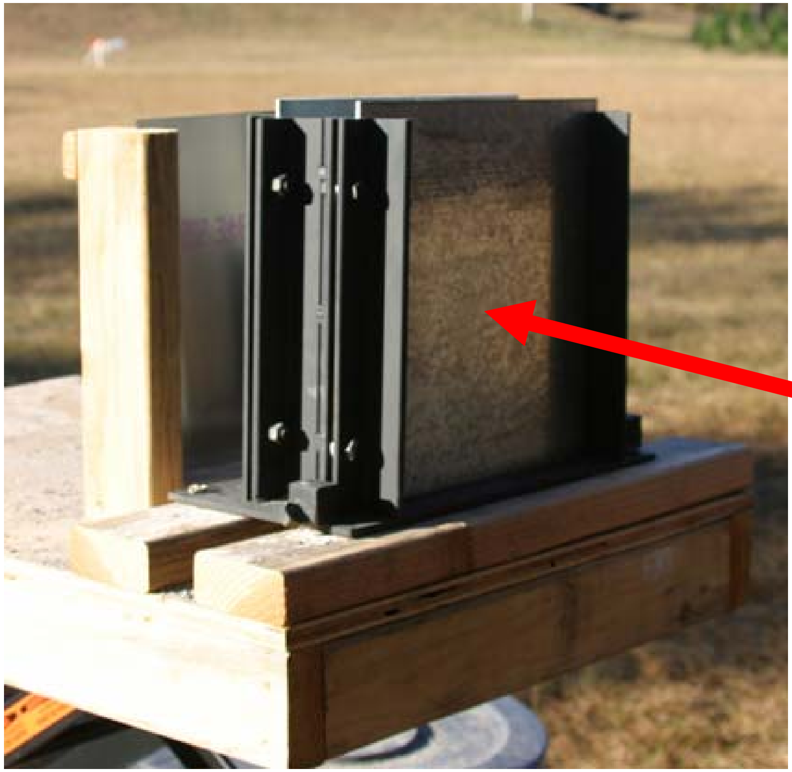


Automobile Windshields

Concrete & Steel

Concrete →





← Steel

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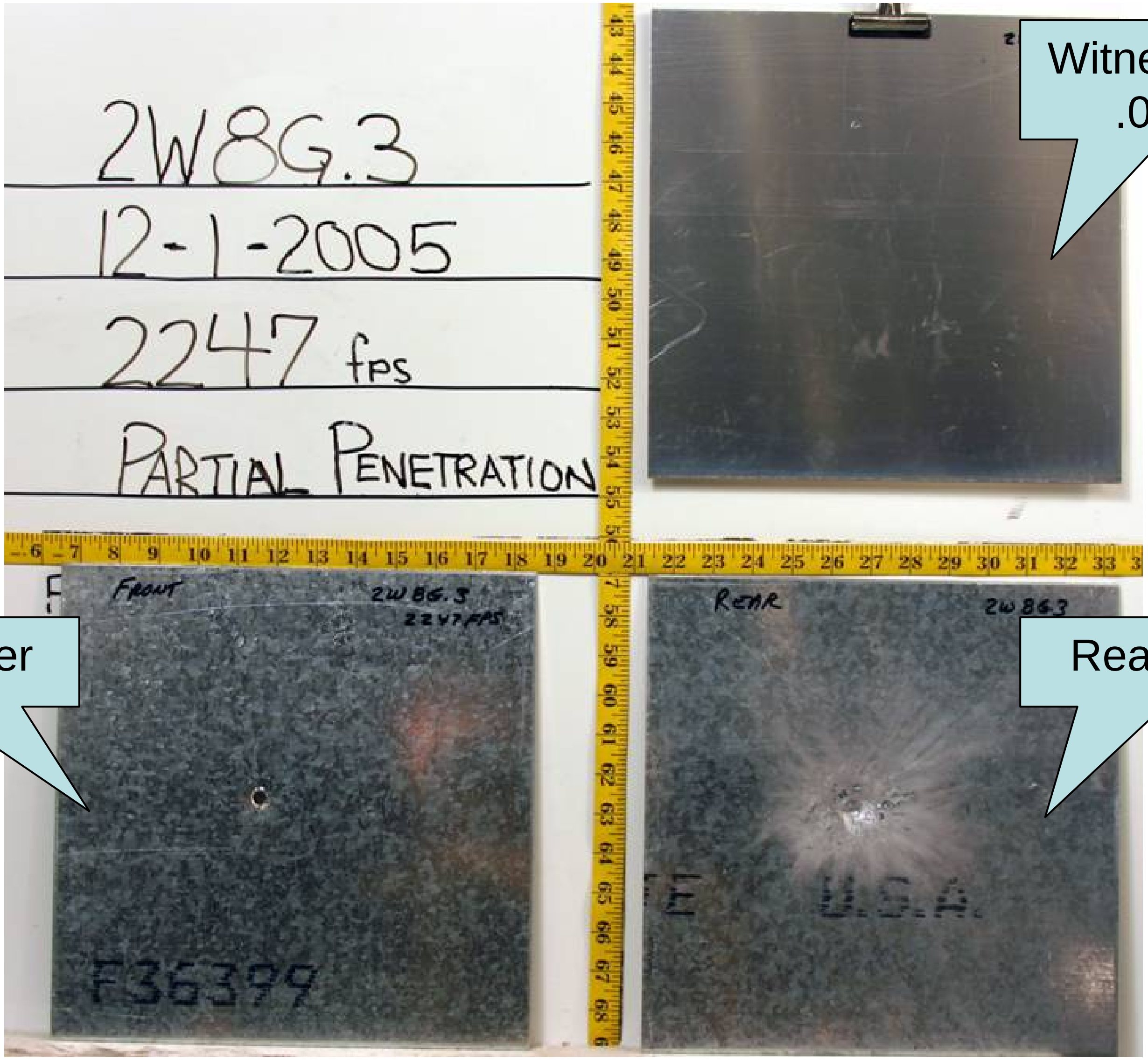
Data Collection

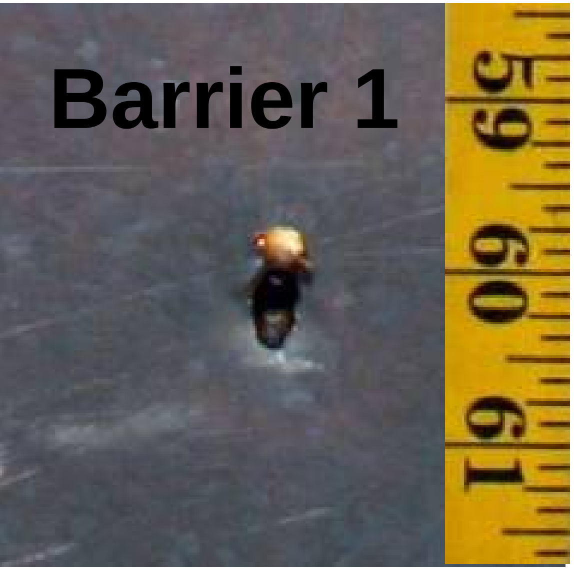


Witness Sheet .020" Al

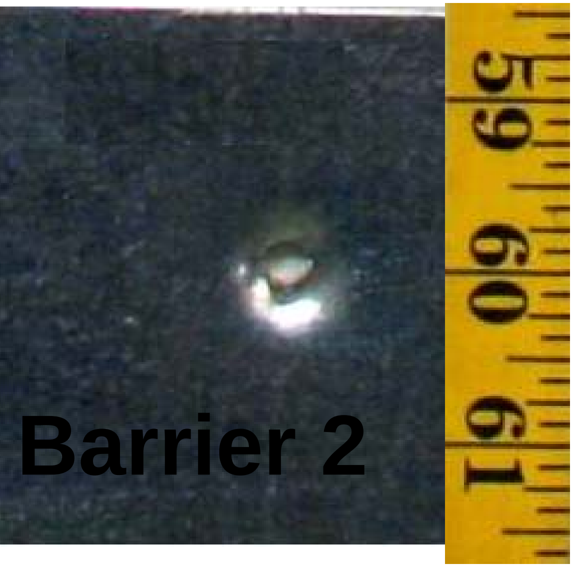
Front Barrier

Rear Barrier

Penetration Assessment



Partial Penetration



Full Penetration

Penetration Assessment of Munitions (PAM) Charts

RND XYZ - XX grain

	Windshield	Heavy Truck Door		Concrete Façade	
Weapon/ Range	**Worst Case**	**Head On**	**Angle**	**4" Hollow**	**4" Filled**
Gun 1 - Range 1	1	1	2	1	2
Gun 1 - Range 2	1	2	2	2	3
Gun 2 - Range 1	1	2	2	1	2
Gun 2 - Range 2	1	2	2	1	3

1	Full Penetration - Minimum # of Shots Required to Penetrate Barrier (80% of the rounds fired were able to penetrate the barrier on the first shot)
2	Partial Penetration - Multiple Shots Required To Penetrate Barrier
3	No Penetration - Maximum # of Shots Required To Penetrate Barrier (80% of the rounds fired were unable to penetrate the barrier on the first shot)

Conclusion

- Provided a quick assessment of currently fielded ammunition
- Determined effectiveness through light intermediate barriers found in field
- Compiled all data for future testing and modeling efforts
- Publishing technical report

Contact Information

Questions?

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Jeremy Lucid – jeremy.lucid@us.army.mil

ALWAYS ON target

National Defense Industrial Association Small Arms Symposium May 2008

.50 cal Short Range Training Ammunition

Author: John MacDougall
john.macdougall@can.gd-ots.com

SHORT STOP®

GENERAL DYNAMICS
Ordnance and Tactical Systems–Canada

GD-OTS Canada New .50 cal SRTA

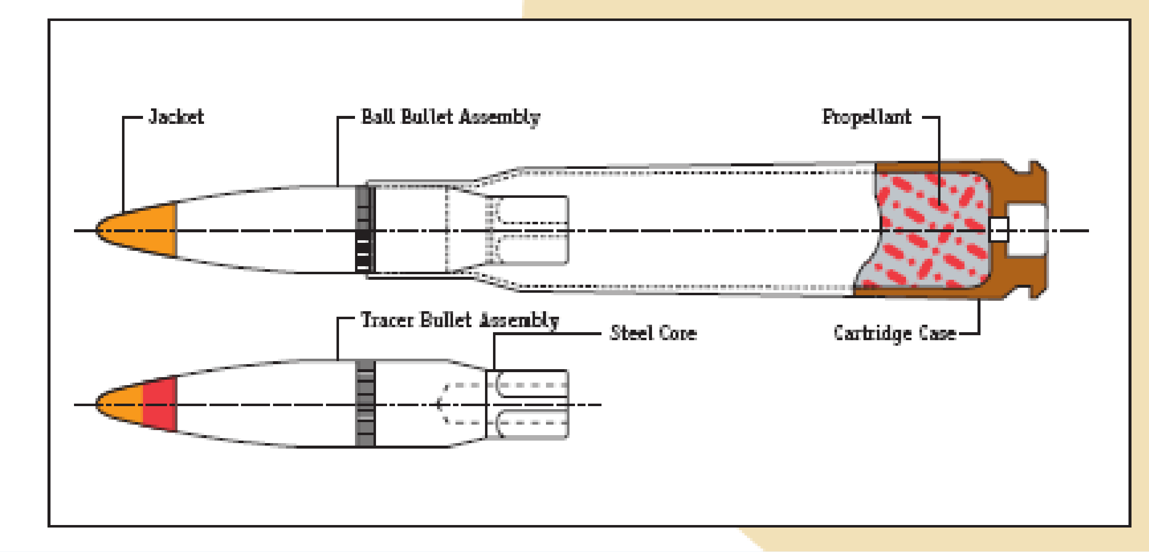
- **Project Objectives**
- **Current Training Ammunition Products/Projects**
- **Concept**
- **Performance**
  – Simulations
  – Test Data
- **Applications/Benefits**
- **Summary**

Project Objectives

- **To develop an improve .50 cal SRTA**
  - Eliminate need for weapon adaptors/ancillary equipment
  - Increase effective ballistic match range
  - Increase functioning reliability

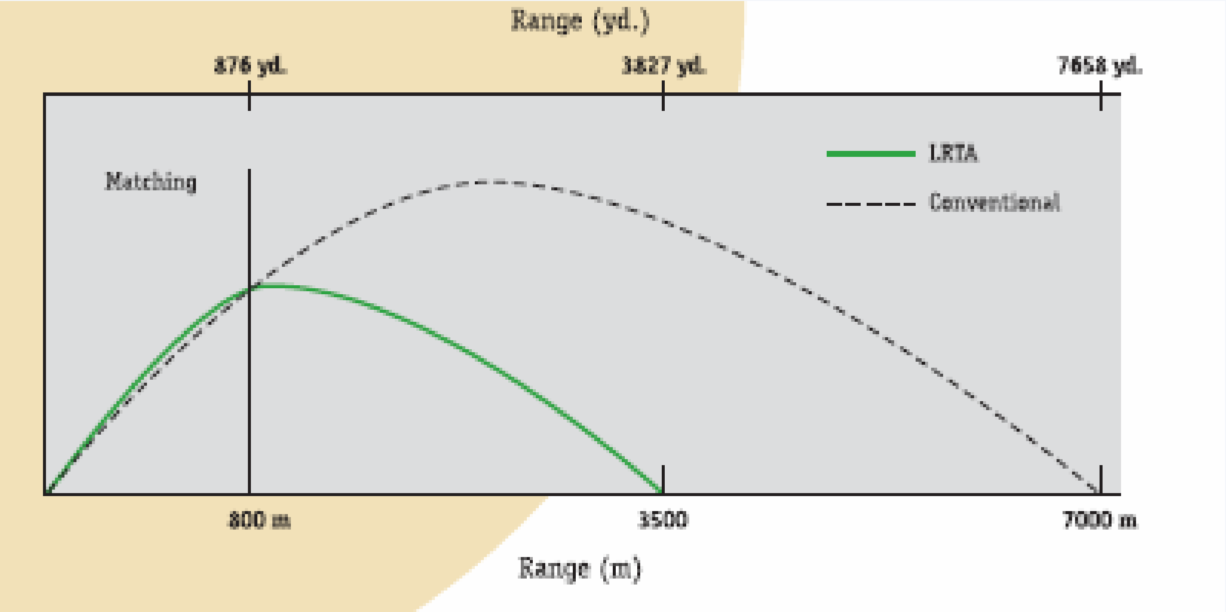
Current Product
.50 cal Limited Range Training Ammunition

- Non-toxic, 45g bullet with rear fins to limit range
- Functions in M2HB and QCB machineguns
- Ball and tracer versions in production since 2001



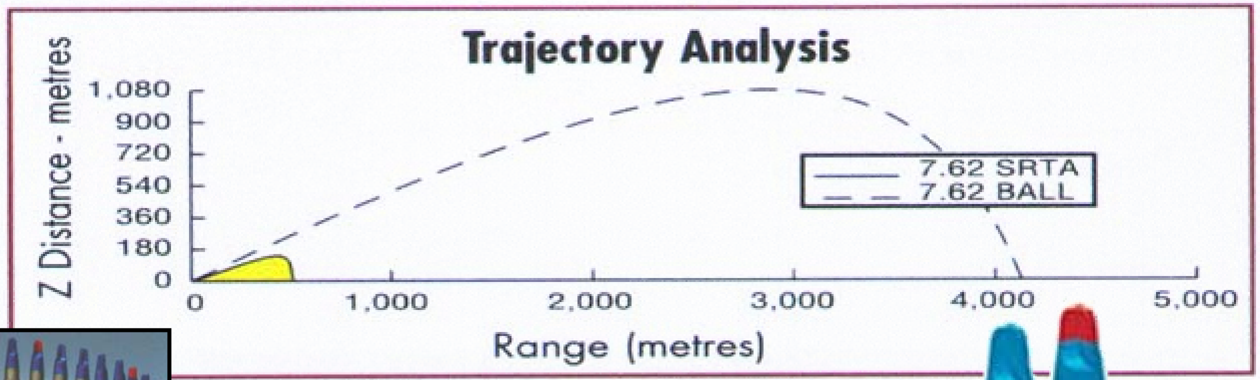
Current Product
.50 cal LRTA

- Accuracy of 30 cm at 550 m range
- Ballistic match up to 800 m with M33
- LRTA = Max range of 3,500 m or 50% reduction vs. M33
- Now in service in 3 NATO armies



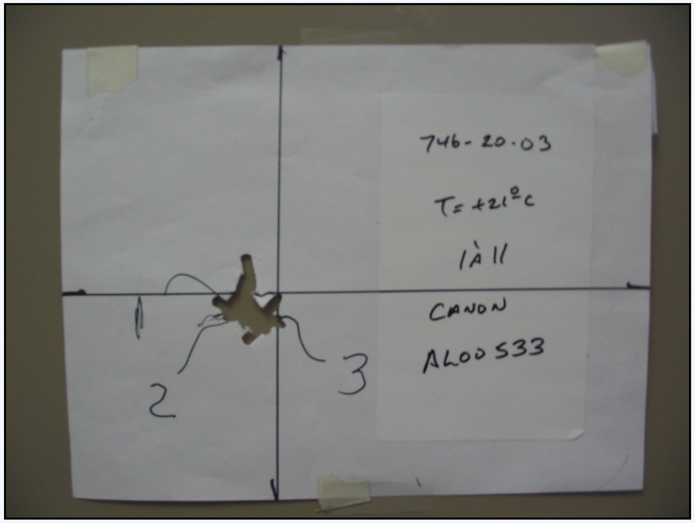
Current Product
SHORT STOP® 7.62 mm SRTA

- 7.62 mm SHORT STOP® training round
- Available in 4B/1T configuration
- Now in Production for DoD as M973 & M974



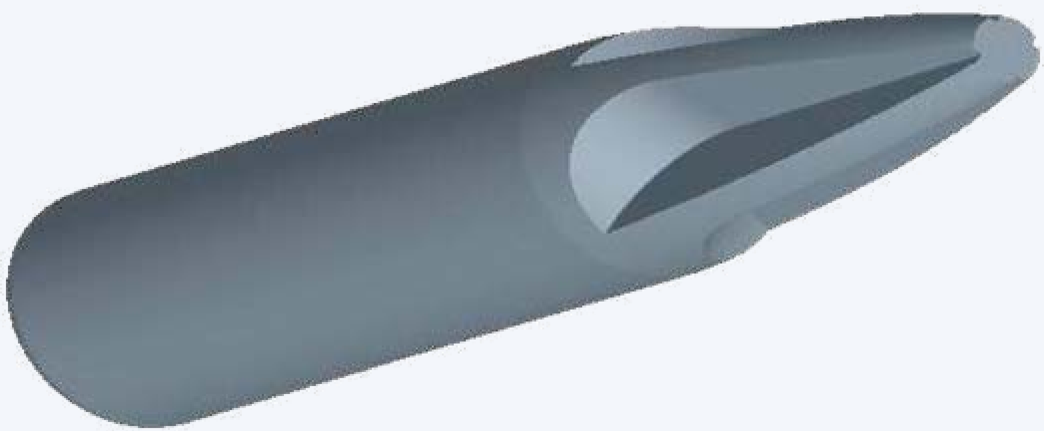
Current R&D Project
SHORT STOP® 5.56 mm SRTA

- Ballistic match to 100 m with max range of 600 m
- Under final development with ARDEC
- Phase III recently awarded



.50 cal SRTA Concept

- **The .50 cal SRTA Cartridge is:**
  - Our newest Short Range Training Solution
  - An Internally-funded GD-OTS Canada R&D program
  - Now in test and evaluation phase



.50 cal SRTA Concept

- **SRTA performance objectives:**
  - No modifications of M2 machinegun
  - Improved ballistic match with M33/M17
  - Reliable functioning from –20 to +50ºC
  - Non-toxic components
  - Max range of 700 m
  - Frangible projectile
    - No splashback beyond 25 m
  - Improved performance vs. M858

.50 cal SRTA Concept

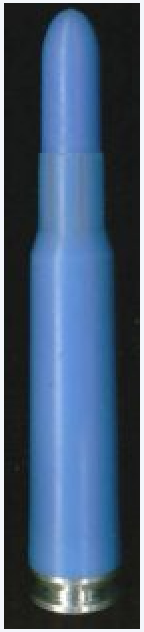
- **The .50 cal SRTA has:**
  - A monolithic, frangible projectile
  - Forward fins with controlled spin technology to limit range
    - Fins introduce a "reverse" spin/drag, opposing rotation
    - The projectile quickly becomes dynamically unstable
  - Very good accuracy due to consistent ballistic performance
    - Yaw on target is trade-off for greatly reduced max range

.50 cal SRTA Performance

- **SRTA performance Objectives/Results**
  - Objective: ballistic match with ball round at 150 m
    - **Result: > 200 m match range possible**
  - Objective: Drop of < 15 cm compared to ball at 150 m
    - **Results obtained: < 5 cm**
  - Objective: Mean radius Dispersion < 30 cm at 150 m
    - **Results obtained: < 15 cm**

.50cal SRTA vs. M858 Comparison

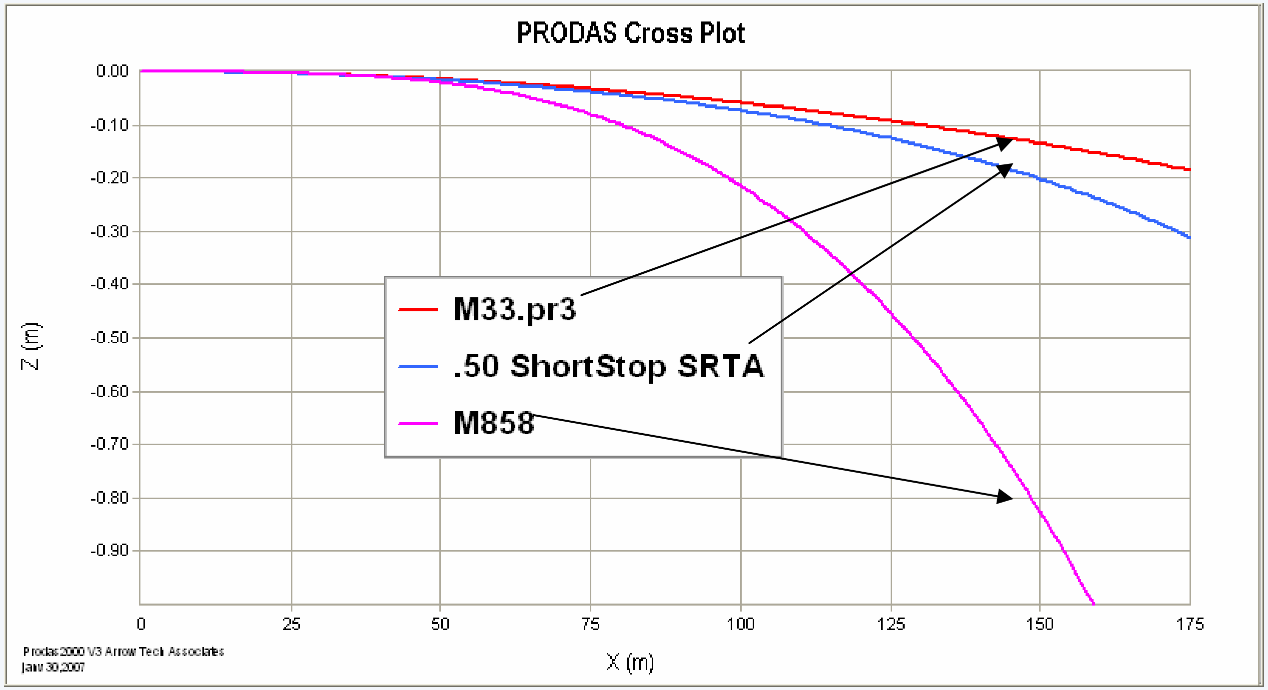
- **.50 cal M858 Ball and Tracer M860 training rounds**
  - Type classified in 1983 and introduced in the US DoD
  - Requires use of M3 Recoil Amplifier Barrel Assembly
  - Muzzle velocity is approx. 4,000 feet per second.
  - Plastic projectile mass is approx. 3.3 grams
  - Ballistically comparable to M17/M33 out to 150 meters
  - Maximum range of 700 meters



.50 cal SRTA Ballistic Simulation

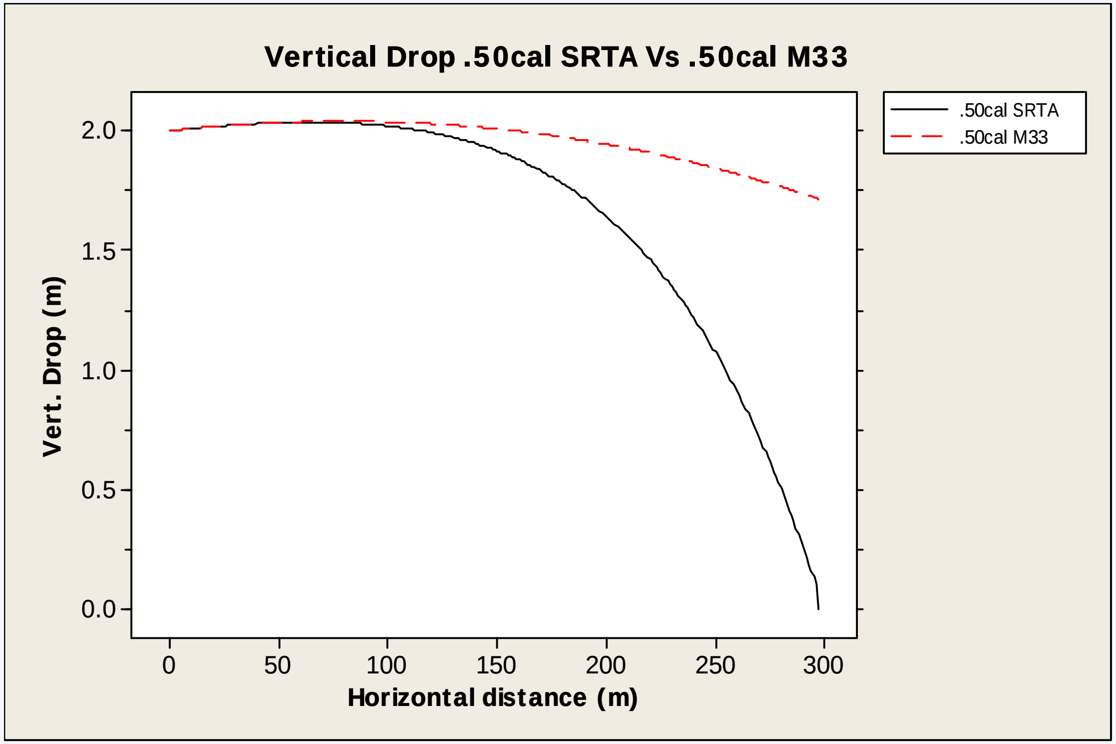
SHORT STOP®

- Comparison of ballistic drop with M858 at 150 m



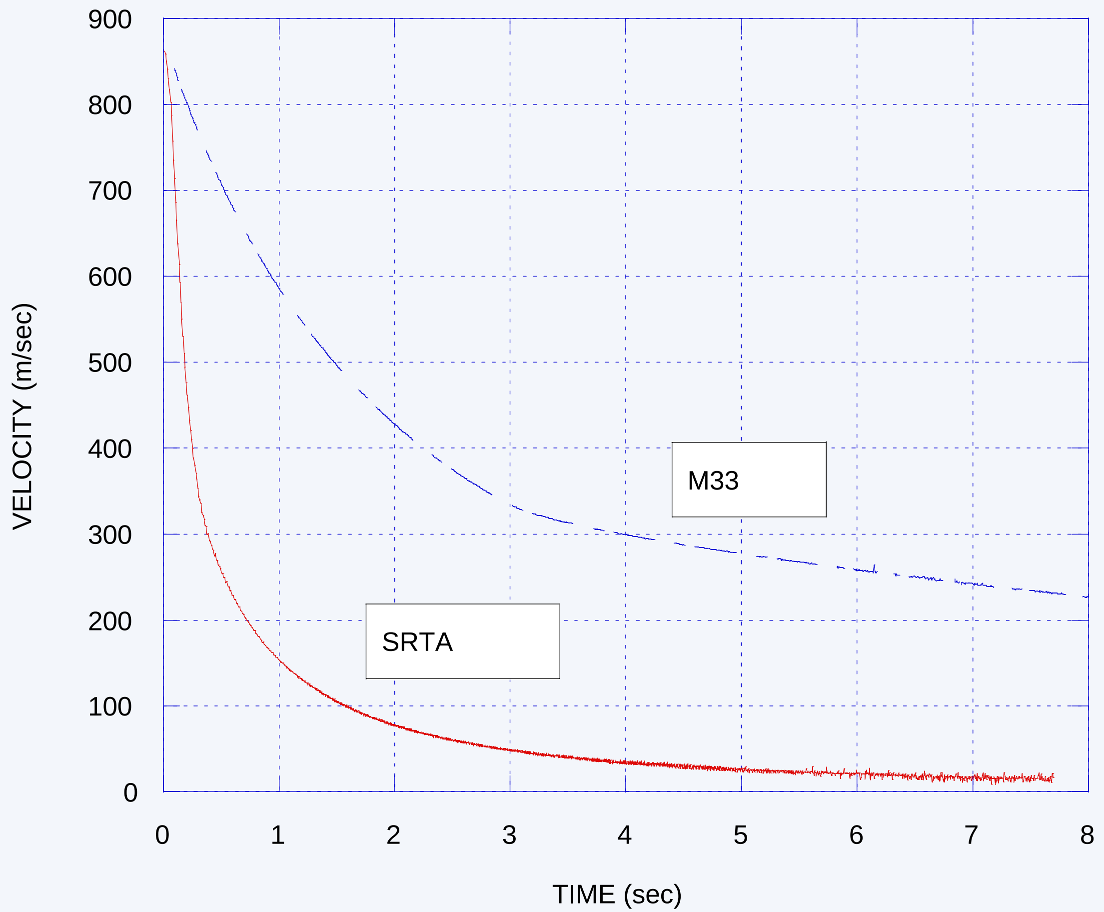
.50cal SRTA Ballistic Simulation

- Comparison of ballistic Drop vs. M33 Ball round



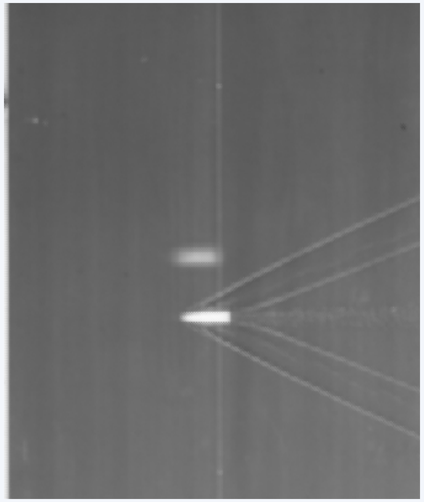
.50 cal SRTA Ballistic Simulation

- Velocity decay vs. M33 simulation with PRODAS

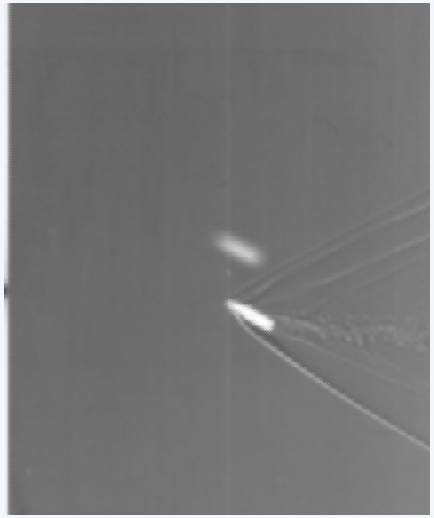


.50 cal SRTA Ballistic Testing

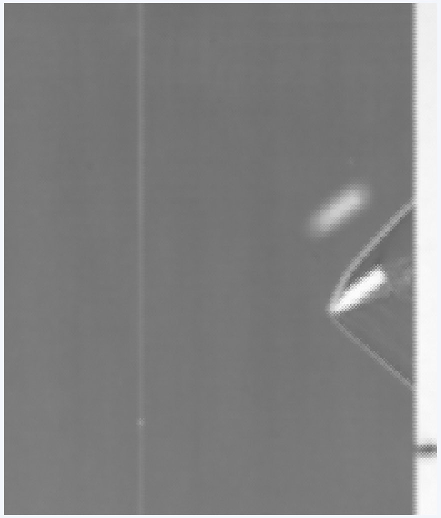
5m



68m



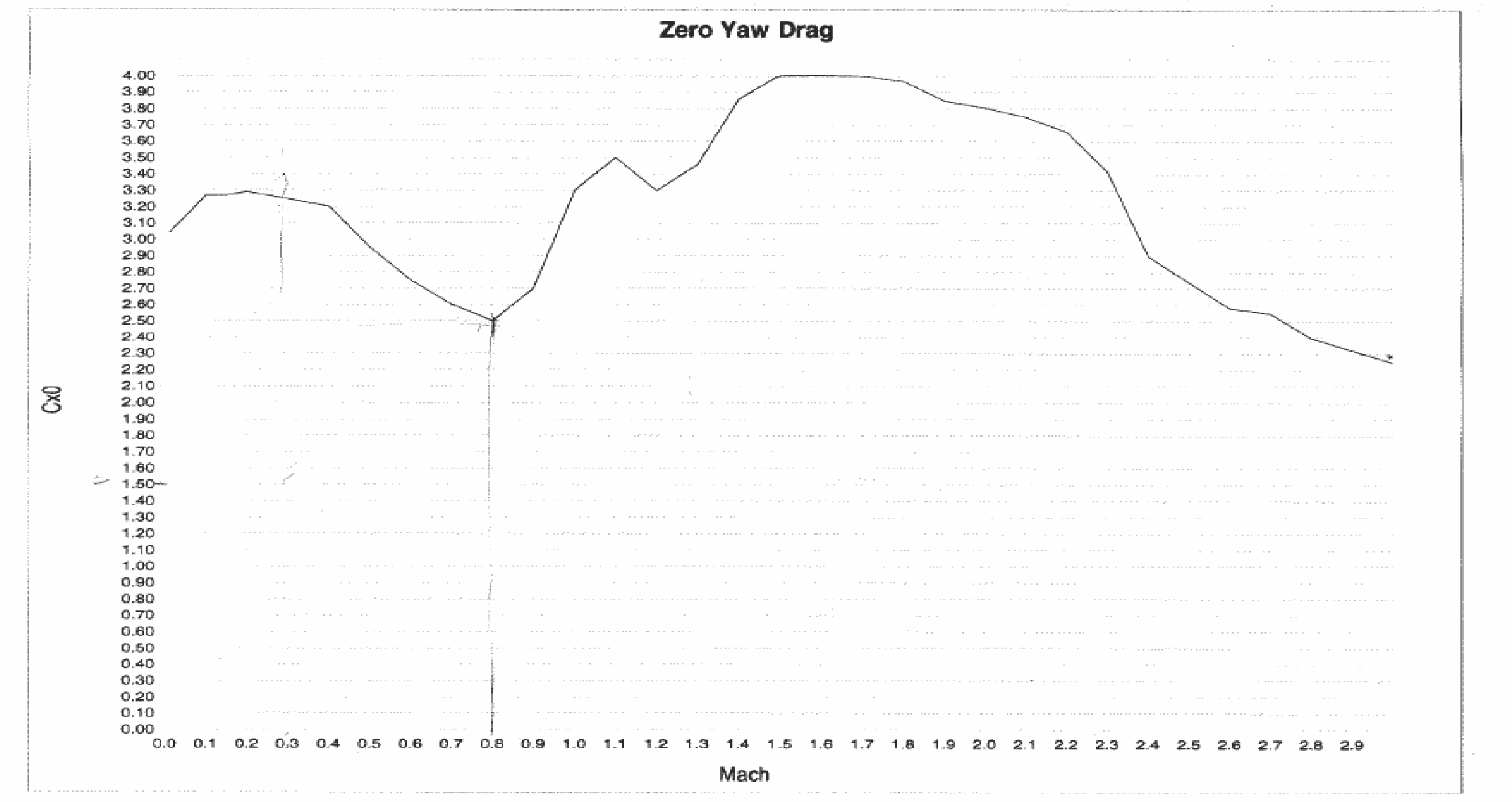
185m



Shadowgraph images from DREV spark range

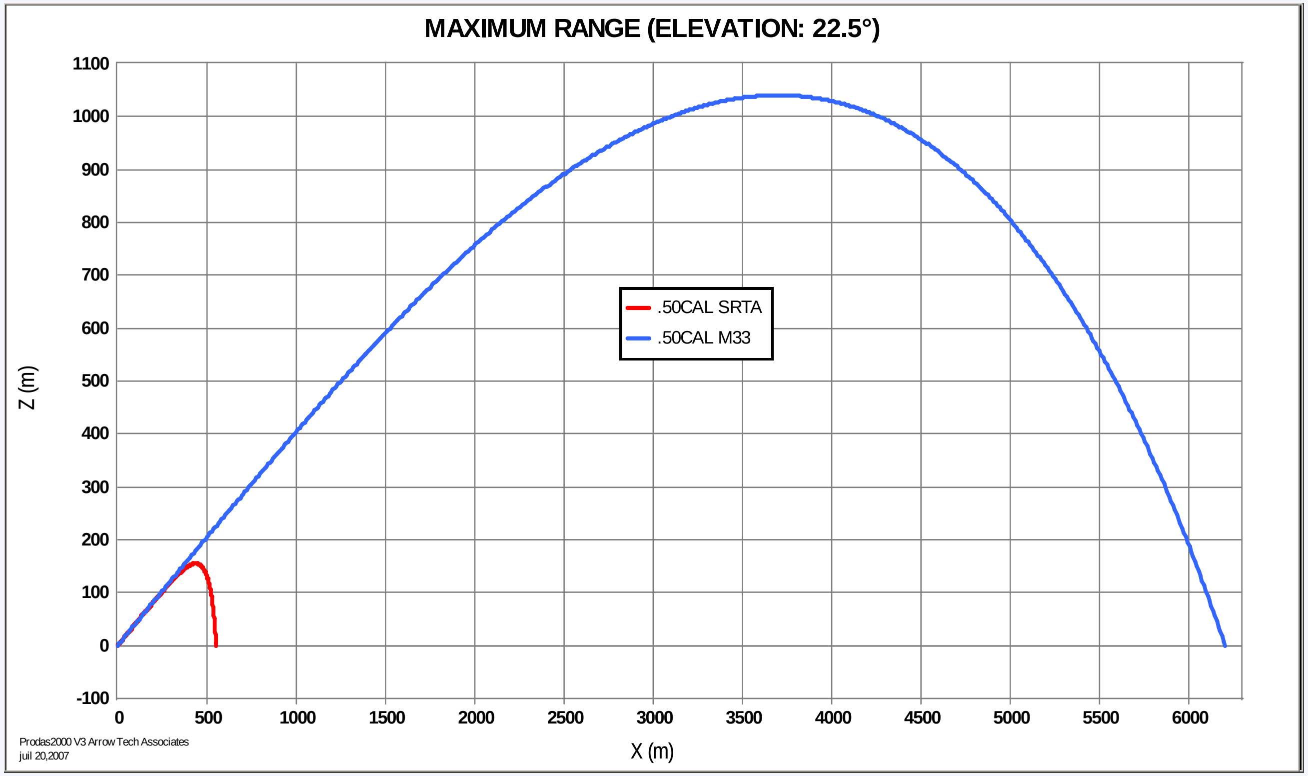
.50 cal SRTA Ballistic Testing

- Typical Drag vs. Velocity curve measured



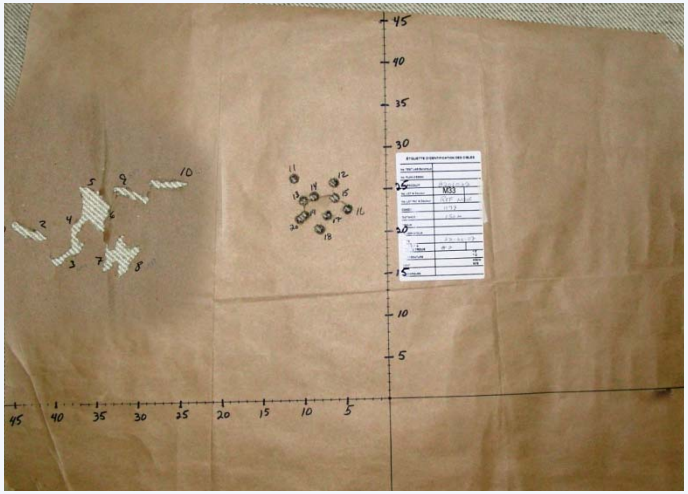
.50 cal SRTA Ballistic Simulation

- **Maximum range simulation with PRODAS**
  - Less than 700 m



.50 cal SRTA Ballistic Testing

- **Ballistic match and accuracy tests at 150 m, June 2007**
  - Reference is M33

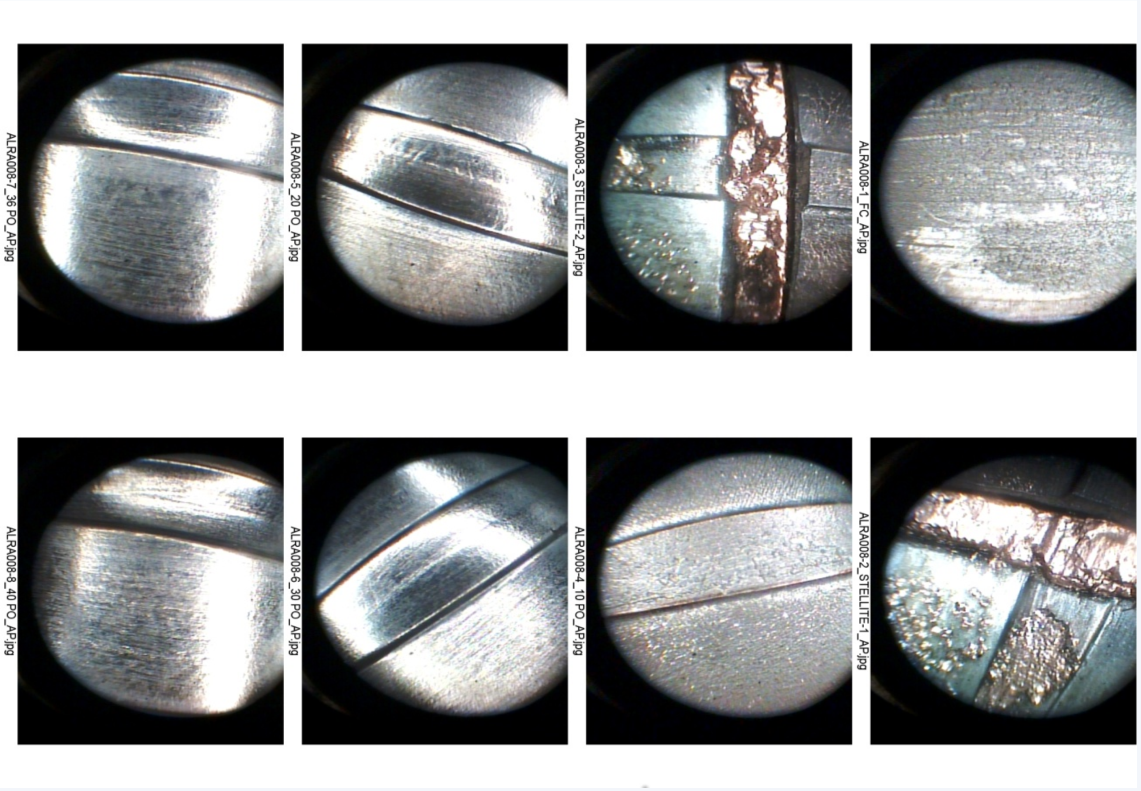


.50 cal SRTA Ballistic Testing

- **Frangibility testing at 50 m range**
  - No penetration of a 10 mm armor plate
  - No splashback at 25 m after 30 shots fired

.50 cal SRTA Ballistic Testing

- Minimal barrel fouling in M2 barrel observed



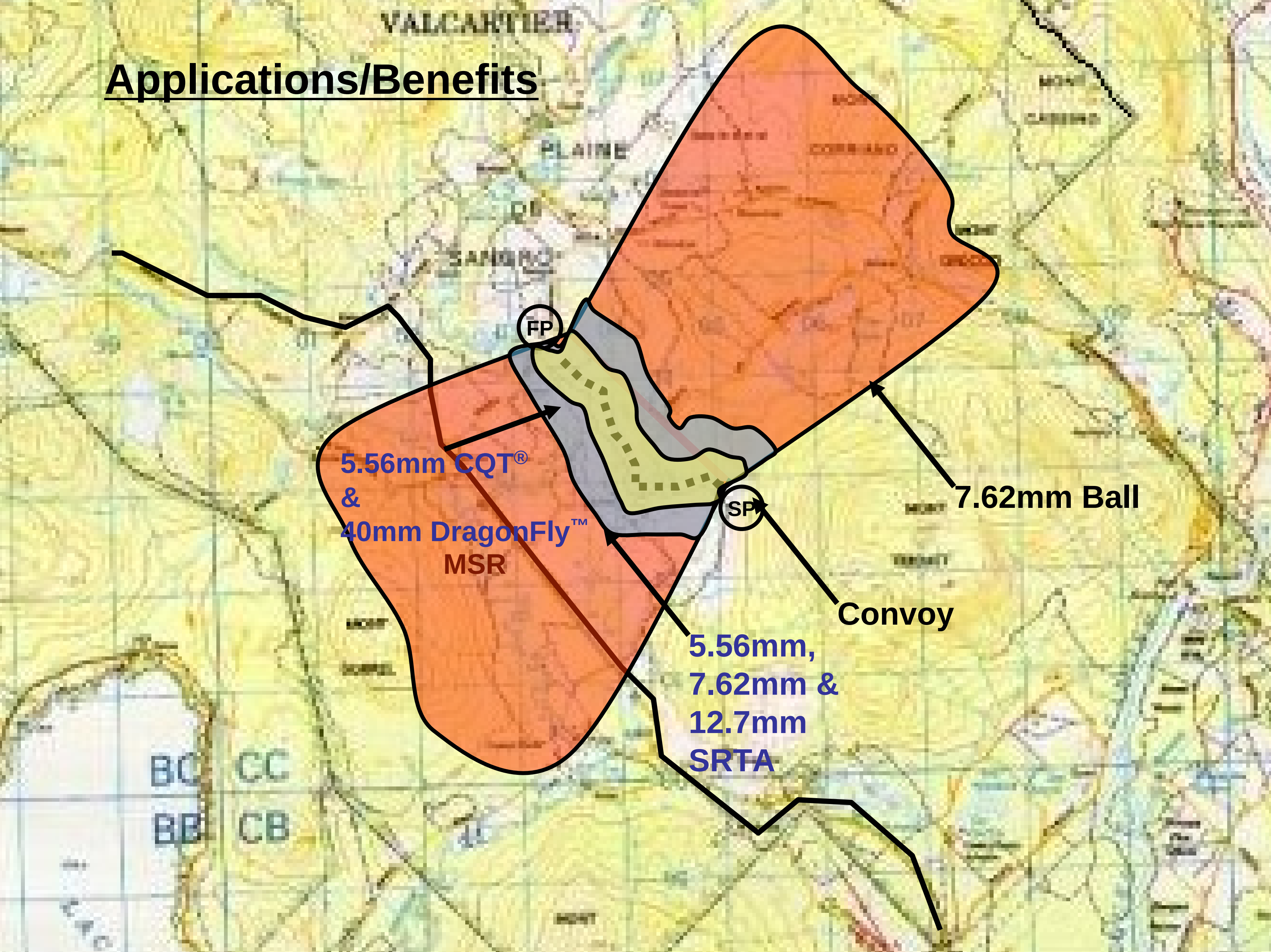
.50 cal SRTA Applications/Benefits

- **Training Applications/Benefits**
  - Maritime training with limited surface danger-zones
  - Used on reduced safety template ranges
  - Training with reactive steel targets
  - Fired on “Lead-free” ranges
  - Enables engagements with targets on 2nd and 3rd floor windows or on overpasses
  - Reduces friction created by units competing for range time

.50 cal SRTA Applications/Benefits

- **March-April 2008 edition of Infantry Magazine**
  - Article entitled: “SRTA allows 360° Training Capability”
  - At Fort Riley, Kansas: “SRTA is 1st Division's means to produce one awesome, realistic and simple training event.”
  - “Only SRTA can provide free-thinking using fire and maneuver in a 360° training environment because of the SDZ”
  - “SRTA allows trainers to condense the battlespace”
  - “SRTA ranges can be created from maneuver spaces”
  - Because of the increases in land resources the training tempo has increased.”
  - “Without SRTA, the 1st Division and the U.S. Army transition team trainers would face significant and difficult obstacles”

Applications/Benefits



.50cal SRTA Summary

- **SUMMARY**
  - The new .50 cal SRTA lead free, frangible concept represents an advance in small arms training technology
  - The new .50 cal SRTA is currently an in-house R&D project
  - It optimizes the use of range training resources due to its significantly reduced danger-template
  - This new product will further enhance the family of:

Short Range Training Solutions offered by GD-OTS Canada

Contact Information

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Ordnance and Tactical Systems–Canada

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Business Development Manager

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E-mail: john.macdougall@can.gd-ots.com

.50 cal SRTA Ballistic Testing

- Weapon cycling video

NDIA

INTERNATIONAL INFANTRY & JOINT SERVICES SMALL ARMS SYSTEMS SYMPOSIUM

DALLAS, TX

Unclassified

Colonel Bob Mattes

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Comparative Testing Office (CTO)
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Office of the Secretary of Defense (OSD)
"The Environment"

Secretary of Defense
Deputy Secretary of Defense

Hon. Robert Gates
Hon. Gordon England

Under Secretary of Defense
(Acquisition, Technology & Logistics)

Hon. John Young

Director, Defense Research & Engineering

Mr. Alan Shaffer
Principal Deputy

Deputy Under Secretary of Defense
(Advanced Systems & Concepts)

Mr. John Kubricky

Comparative Testing Office (CTO)

Col Bob Mattes

Defense Acquisition Challenge (DAC) &
Foreign Comparative Testing (FCT)

CTO Priorities

- ***Warfighter Issues***
  - ***Improved Operations***
    - ✓ Effectiveness (lethality, accuracy, endurance)
    - ✓ Survivability (protection, agility, stealth, medical)
    - ✓ Force Protection (defensive systems, detection, armoring, chemical - biological defense)
    - ✓ Sustainability (lighter / combined equipment, longer missions, better batteries)
  - ***Direct Warfighter Support***
    - ✓ Logistics (supply chain management in the field, equipment reliability)
    - ✓ Teaming (e.g., Network & Info Centric Operations at the tactical or operational level)
    - ✓ Surveillance, tagging and tracking (blue and hostile forces tracking, friendly identification)
  - ***Warfighter Employment***
    - ✓ Planning capabilities (large unit employment)
    - ✓ Coordinating capabilities (Network / Info Centric Operations at the strategic level)
    - ✓ Transport capabilities (getting to and from the fight)
    - ✓ Operational readiness (equipment availability, maintainability, training)
- ***Other National Priorities, as provided in Defense Planning Guidance (DPG)***

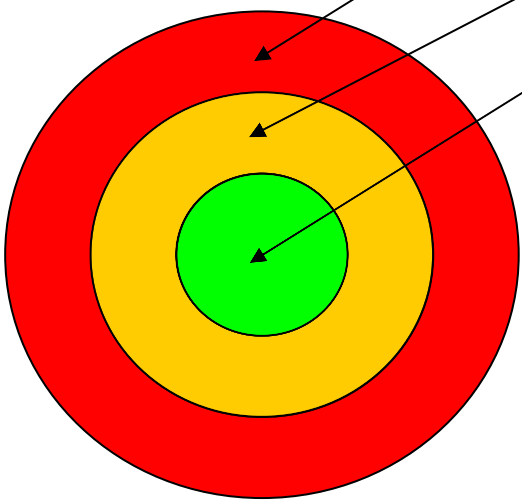
FCT Performance Metrics

The Past 28 Years:

581 Projects Started, 507 Completed

271 Projects Met Service Requirements

193 Projects - Procurements Worth over $8.5B



- **Participation of 28 Allied & Friendly Countries**
- **OSD Investment: $1.1B (Constant FY08 $$)**
  - **Estimated RDT&E Cost Avoidance: $7 Billion**
- **Accelerated Fielding Averaging 5-7 years**
- **Procurement Rate over 80% in the Past 7 Years**

Bilateral Benefits: Vendor Teaming with U.S. Industry in 33 States

DAC Performance Metrics

Key Program Success Metrics:

Since the program inception in FY2003, OSD has initiated 105 projects;

- 38 projects have been completed to date,
- 28 met Service or Agency testing requirements,
- 23 have transitioned to PoR (over 80% transition to procurement rate)
- 4 projects were terminated due to inability to satisfy testing or Program of Record priorities.

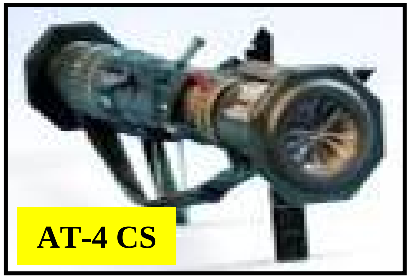
Results:

66 projects funded at $91M

23 projects have procurements that total $320 million,

- 16 projects have yielded capabilities currently deployed to our warfighters in Iraq, Afghanistan, or at U.S. training facilities.
- Return on Investment ~ 9:1,
- Participation from 85 companies, 36 states.

CTO & Warfighting Operations



AT-4 CS

Close Quarter Battle Pistol

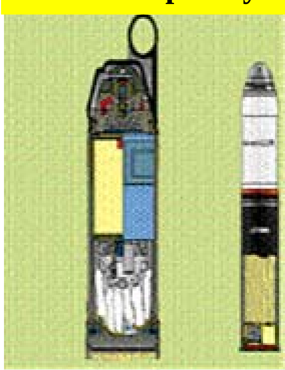
SOF (Special Operations Forces) Combat Assault Rifle (SCAR)

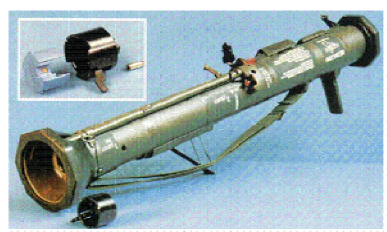
20mm Anti-Material Rifle

Muzzle Break Sound Suppressor for MK48 and M240

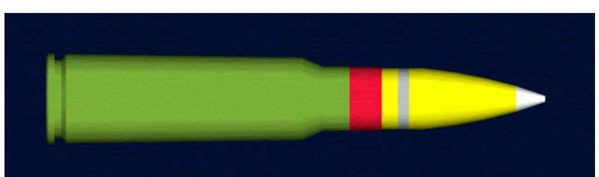
AT-4CS (Confined Space) Enhanced Blast Tandem Warhead

Multi-Role Anti-Armor Anti-Personnel Weapon System - MAAWS





Advanced Demolition Weapons



30mm Programmable Air Burst Munitions

High Rate-of-Fire .50 Caliber Machine Gun

Continued

40mm Enhanced Grenade Launcher Module for M4 Carbine

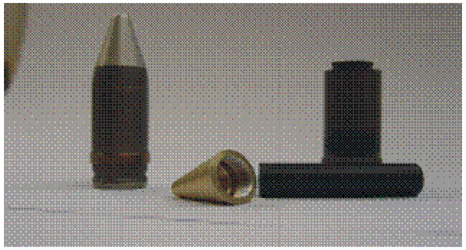
7.62mm Lightweight Machine Guns and Semi-Rigid Ammo Container

Joint Service Combat Shotgun

Joint Ranger Anti-armor, Anti-personnel Weapon System Ammunition Upgrades, Phase I

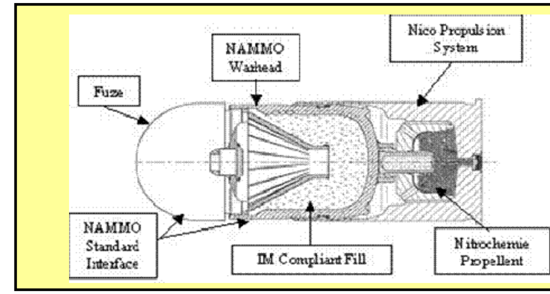
5.56mm Lightweight Machine Gun

Ammunition



20mm Replacement Round

Lightweight Hand Grenade



40mm High Explosive Dual Purpose

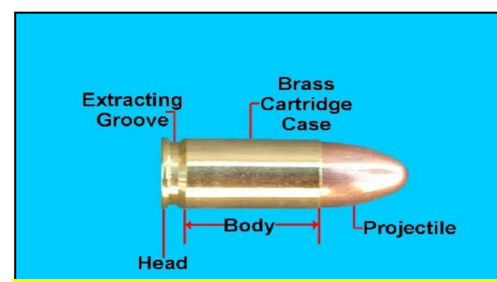
40mm Low Velocity,
High Explosive Dual Purpose

30mm APFSDS-Tracer

Advanced Lightweight Grenade Launcher Ammunition (ALGL-A)

40mm Dud-Reducing M430A1E1 Cartridge

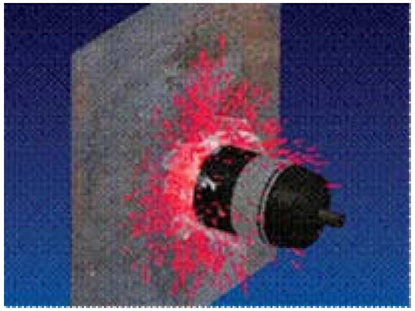
40 mm Practice Grenade



9mm Reduced Environmental
Hazard Ammunition (REHA)

Training Devices / Non-Lethal Systems

M4/M16 Training Bolt



40mm Tactical Marking, Day/Night Training Cartridges

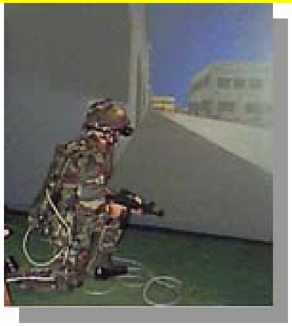
Special Effects Small Arms Marking System for M249 SAW

Individual Serviceman Non-Lethal System

7.62 mm Short Range Training Ammo

21mm Trainer for M72 Light Anti-Tank Weapon

MK47 Crew-Served Weapon Trainer



Dismounted Infantry Virtual Simulation for Military Operations in Urban Terrain

When a Vendor Walks Through My Door …

… I don’t want to hear what they are selling

… I want to hear what problem they are solving for the warfighter

… Some indication that they…

- Have done their homework

- Understand the problem

… And only then how they propose to solve it.

DAC & FCT Key Points of Contact

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TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

7.62mm, Limited Range Lethal Round For USCG
Informational Brief for **NDIA 2008**
20 May 2008

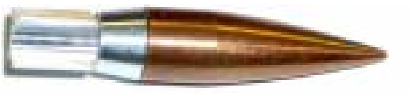
Project Overview & Objectives

- **Overview**
    - JSSAP funded effort initiated in FY04 to design, develop, and demonstrate a 7.62mm Limited Range Lethal Round (L2R2) that meets the unique needs and requirements of the US Coast Guard for use in harbor security applications.
- **Objectives**
    - Capable of engaging and defeating a variety of seagoing vessels and personnel targets
    - Reduced maximum range to minimize collateral damage to the areas surrounding the locations where the round will be employed.
    - Success of program may lead to future “TC”, production & fielding.

Customer Requirements

M80

L2R2



- **Defeat 1/4 inch of mild steel at 200 meters when fired from a M240B machine gun, at up to a 45-degree angle**
- **Match trajectory of M80 out to at least 400 meters.**
- **Capable of defeating soft target out to at least 400 meters.**
- **Maximum range of 2000 Meters (1500 Meters desirable)**
- **Capable of being fired from an M14 rifle and M240 Machine Gun with no weapon adapters / modifications**

Summary from 2006

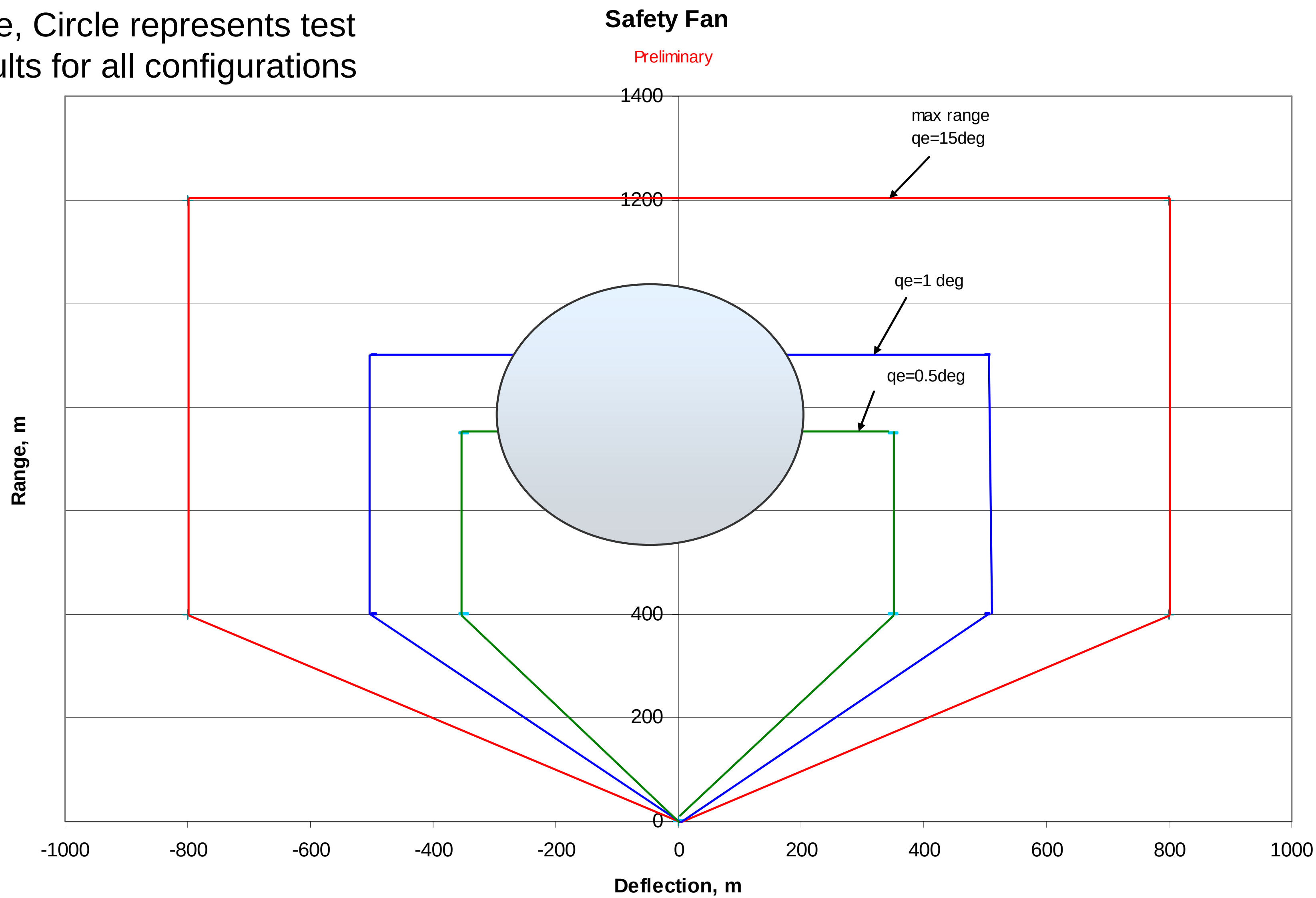
- 3-piece projectile design satisfied penetration requirements
- Radar testing necessary to verify maximum range
- Additional modifications required to improve Dispersion

Radar Testing

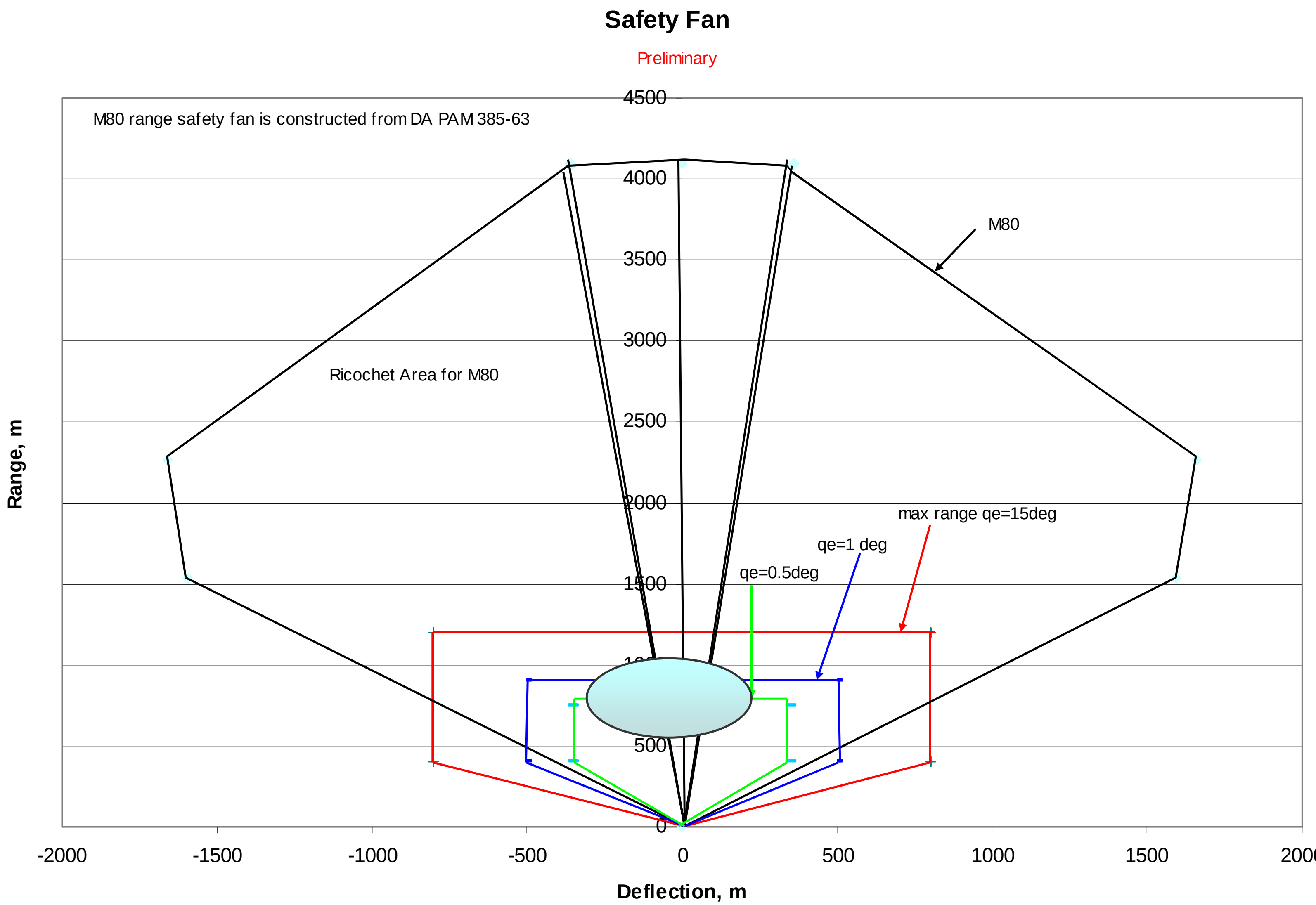
- Radar Testing was performed at the Aberdeen Test Center
- Tested 6 Configurations
  - Long Fin
    - Low Propellant Charge
    - High Propellant Charge
  - Medium Fin
    - Low Propellant Charge
    - High Propellant Charge
  - Short Fin
    - Low Propellant Charge
    - High Propellant Charge

Radar Test Results/L2R2 Safety Fan

Note, Circle represents test results for all configurations



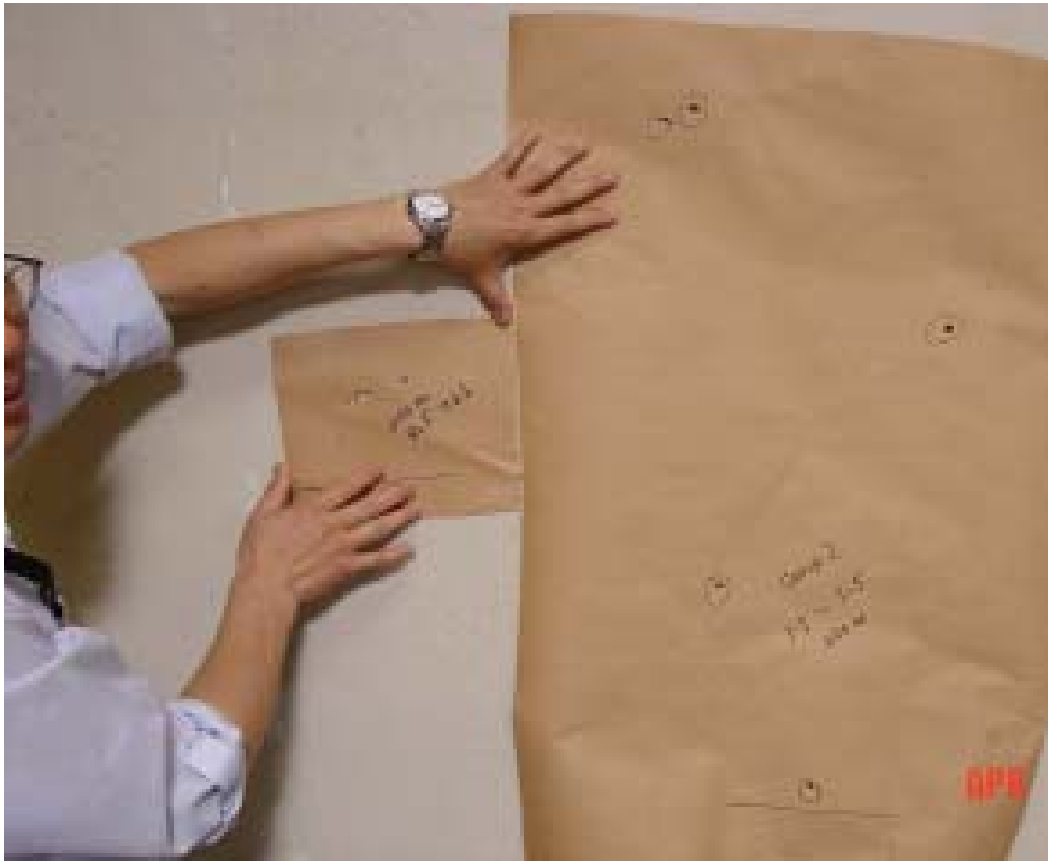
M80 and L2R2 Range Safety Fan Comparison



Long Fin Dispersion Testing

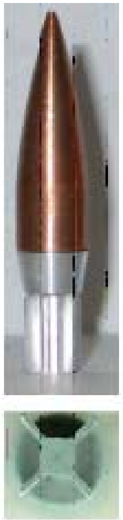
- Fired three five round groups
- Average Circular Error Probable (CEP)
  - 1in for M80
  - 9in for 3-Piece Rear Fin Design
- Unacceptable dispersion
- Redesign 3-piece projectile and fabricate a new alternative

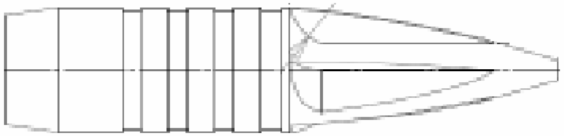
L2R2 and M80 @ 200m

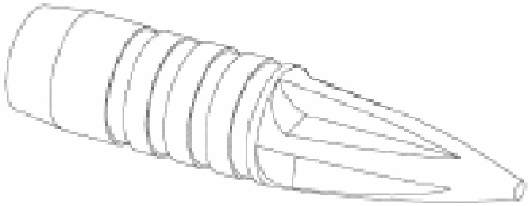


Technical Description of New Designs

- Three new designs have been investigated:
  - Three (3) piece design:
    - Aluminum fins with small stem at the center
    - Copper jacket
    - Tungsten penetrator
  - Three (3) piece design:
    - Aluminum fins with a large stem at the center
    - Copper jacket
    - Tungsten penetrator
  - One (1) piece design:
    - Brass Banded Solid with sections removed from the ogive (forward facing fins)







- Standard 7.62mm, M80 ball cartridge case, primer, and propellant

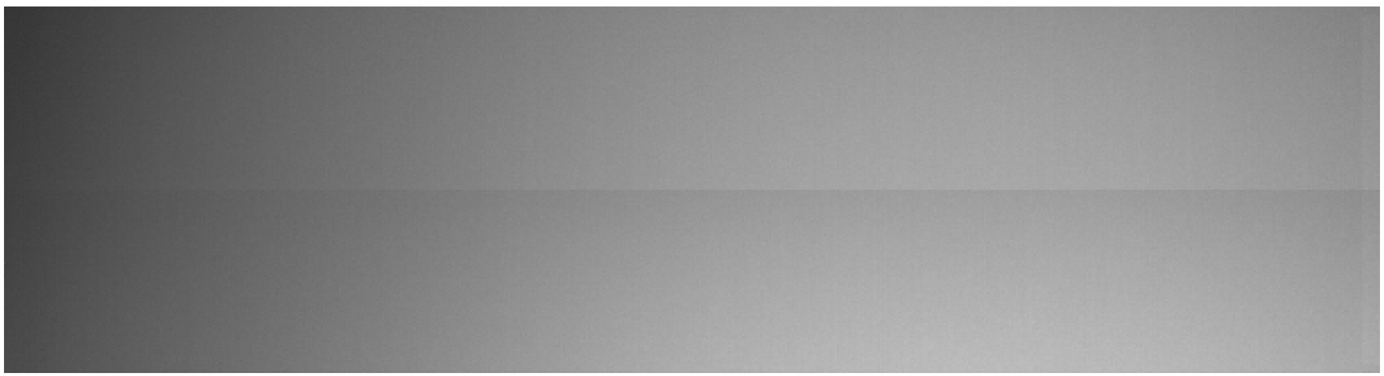
- Limited testing demonstrated reliable weapon function and ability to meet desired muzzle velocity

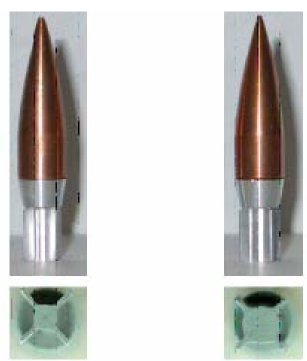
New Designs Testing

- Tested dispersion and target penetration
  - – Banded Brass Projectile without fins penetrated target, low dispersion
  - – Both 3-Piece design penetrated target, no improvement in dispersion
  - – Banded Brass Projectile with fins didn’t impact target.

Rear Finned Projectile

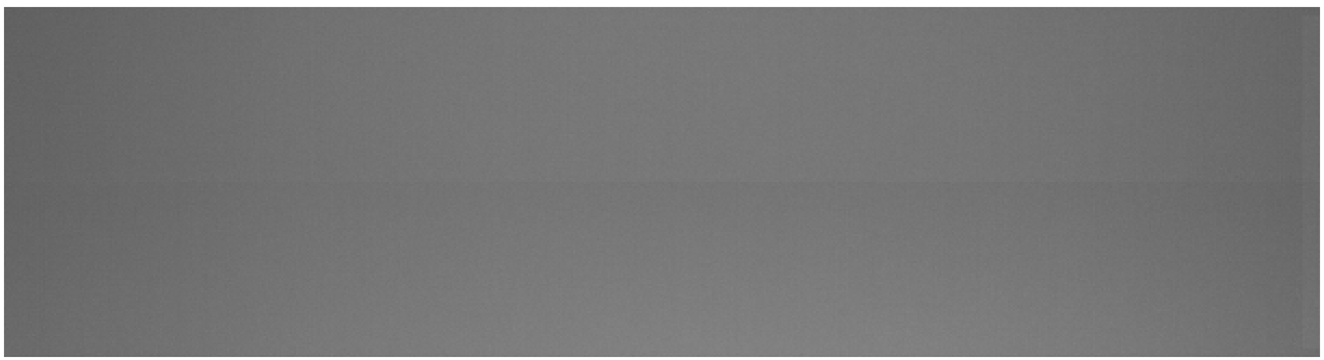
High-speed video of rear finned 3-Piece projectile with center stem @ 15ft from muzzle

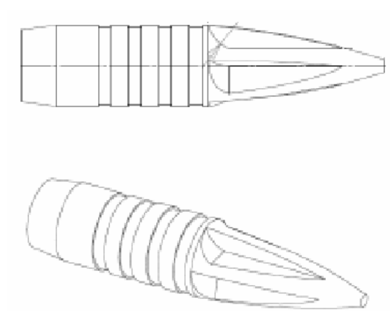




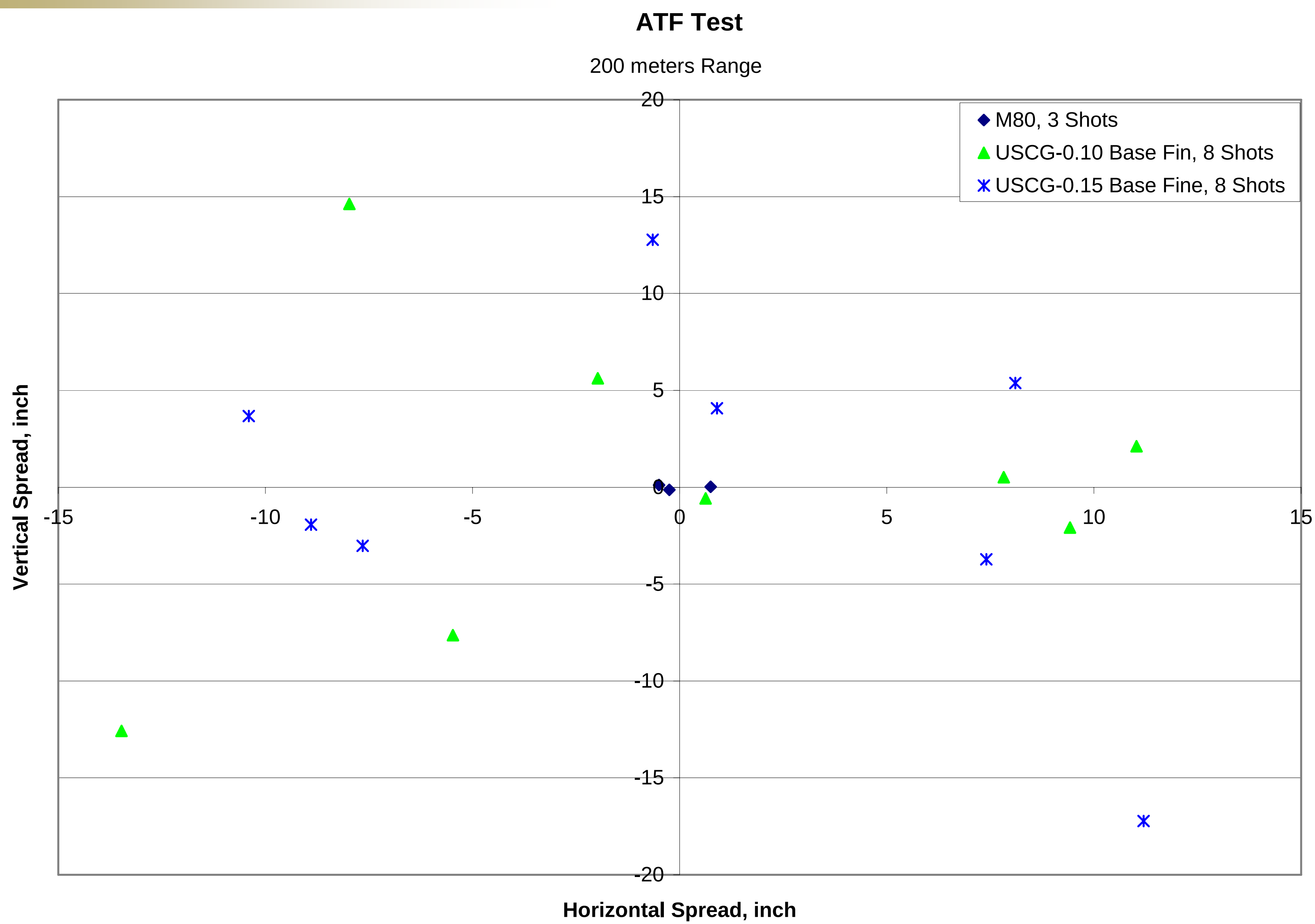
Forward Facing Finned Projectile

High-speed video of Banded Solid with Forward Facing Fins @ 15ft from muzzle





Dispersion Testing Results



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Testing Conclusions

- Rear Finned Projectile
  - Redesigned twice to improve dispersion
  - Minimal improvements in dispersion
  - Design abandoned due to possible tracer requirement
- Forward Facing Finned Projectile
  - Poor stability, didn't impact target
  - Promising concept, cg must be shifted closer to nose
  - Design can accommodate tracer mix

Corrective Actions

- Needed more stable baseline design
- Chose the Standard 7.62 NATO Design, M80
- Designed a solid brass projectile with dimensions equivalent to M80
- Machined forward facing fins
- Modeling showed that it would meet max range requirement

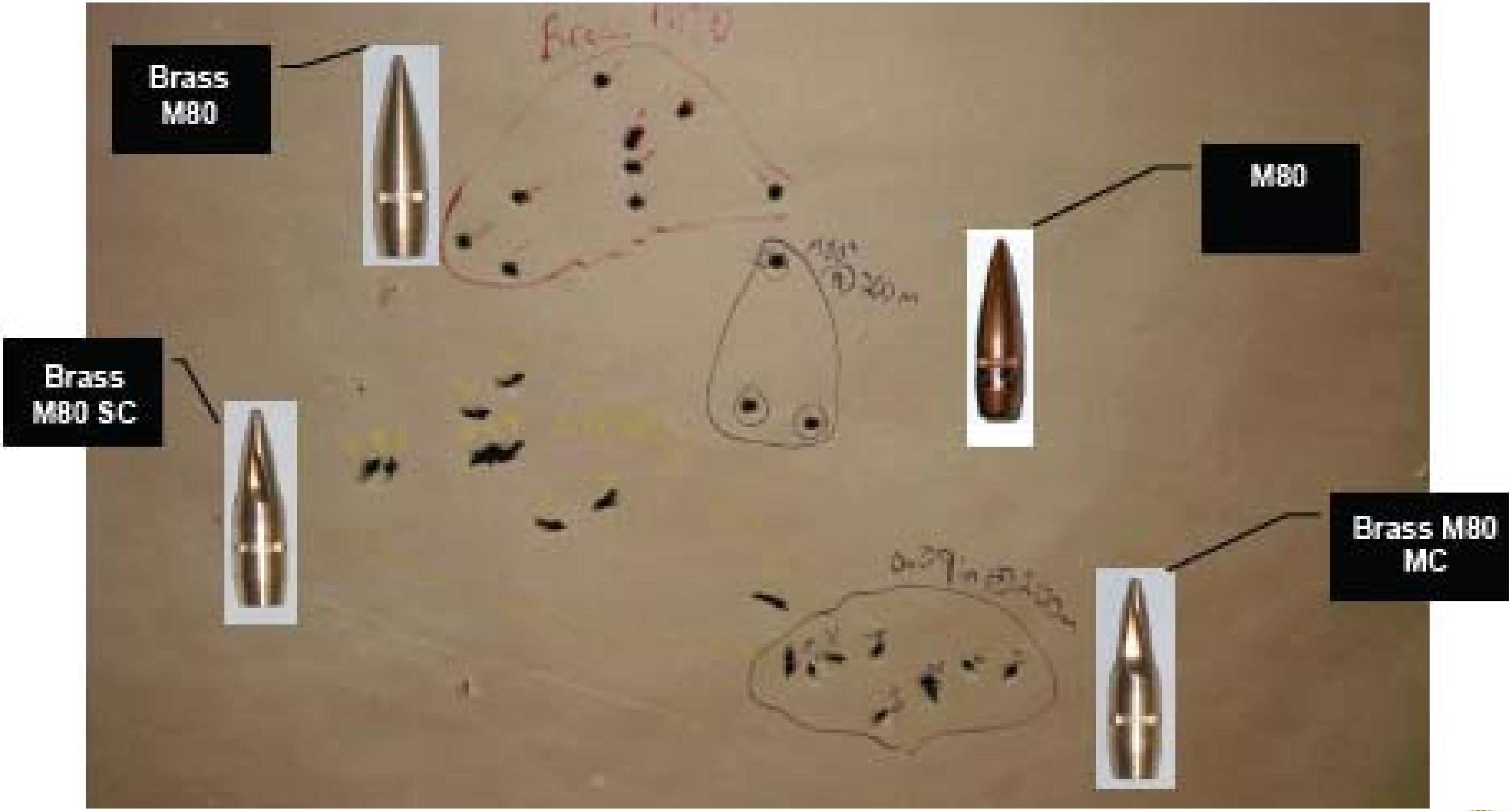
New Designs Testing

Tested dispersion and target penetration (0.25" mild steel) for the designs displayed below.

Forward Facing Finned Projectile

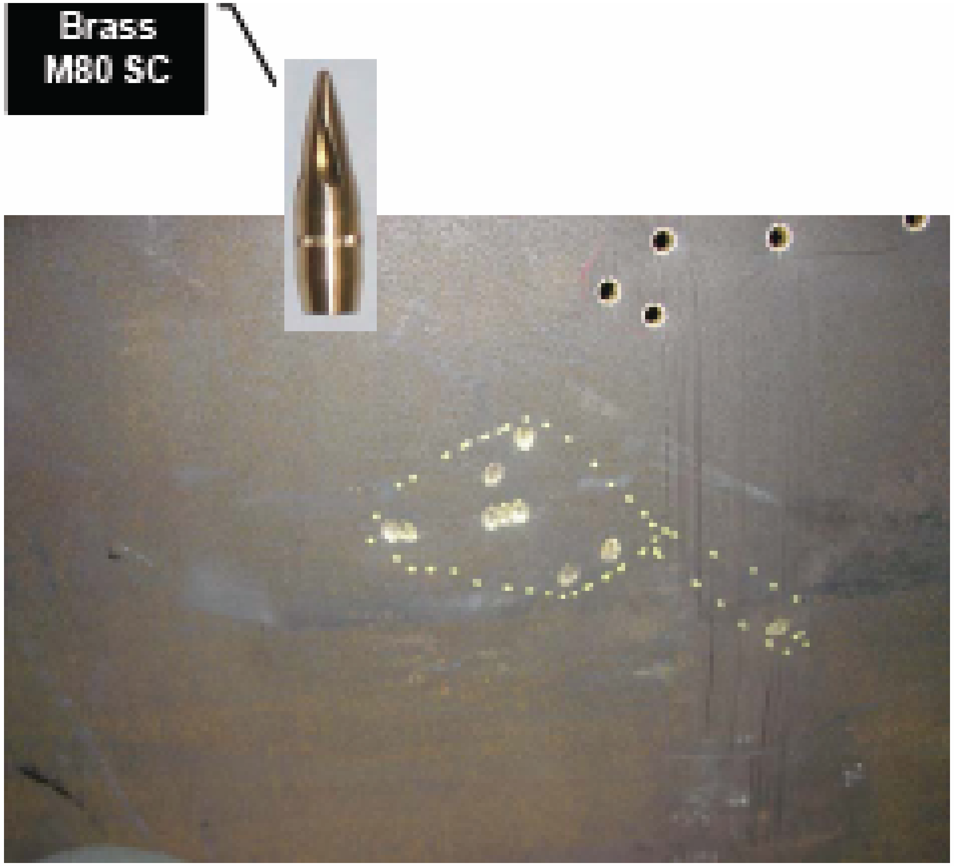
High-speed video of Brass M80 with Forward Facing Fins @ 15ft from muzzle

Test Results, Dispersion @ 200m



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Test Results, Penetration



Summary & Future Tasks

- Brass M80 with forward facing fins
  - Low dispersion
  - Poor target penetration
- Future Tasks
  - Model and Simulate projectile target penetration
  - Perform Spark Range Testing
  - Redesign for penetration and improved dispersion
  - Dispersion test at 400m
  - Radar test for max range

Questions?

Contact Info

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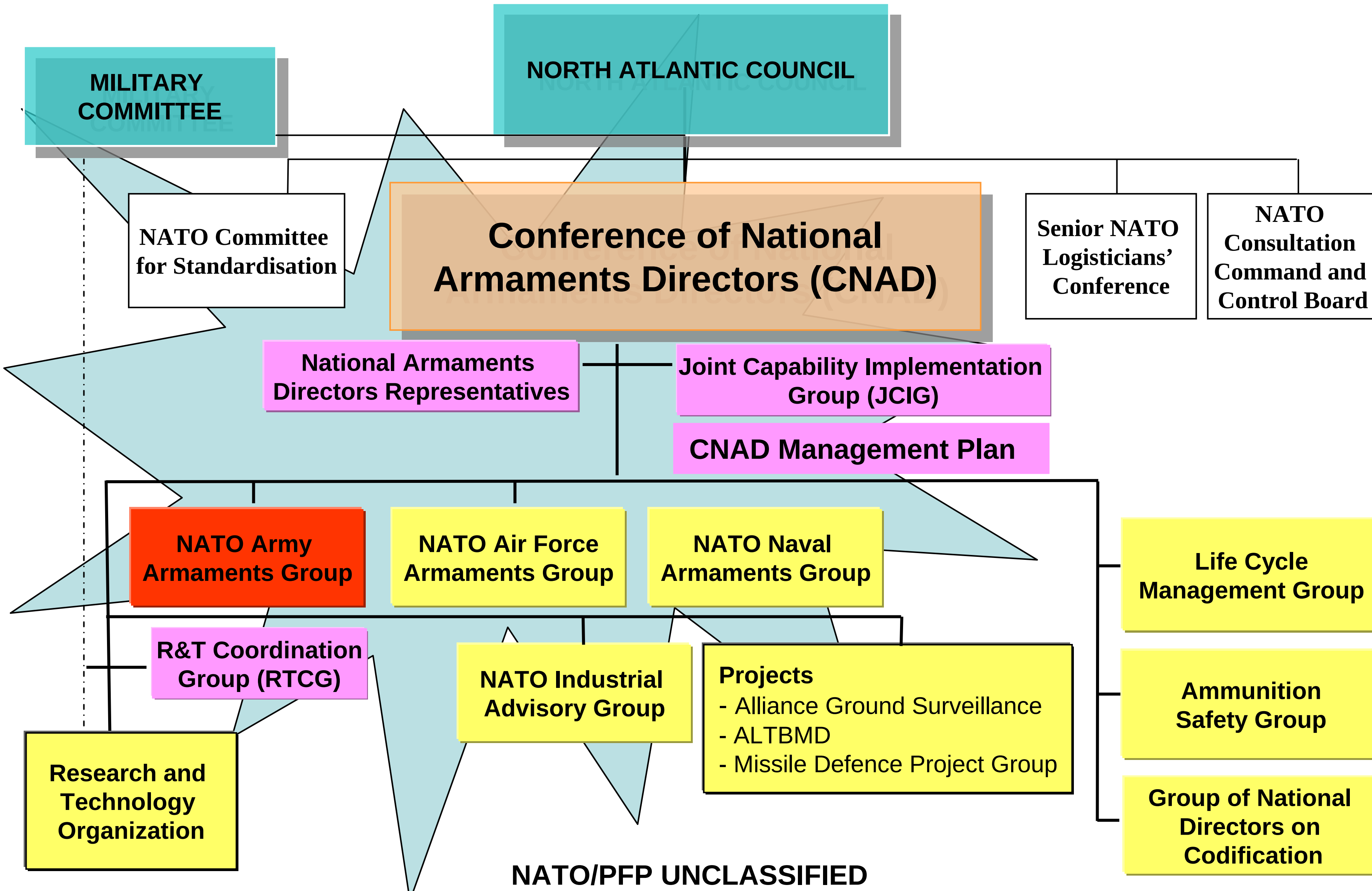
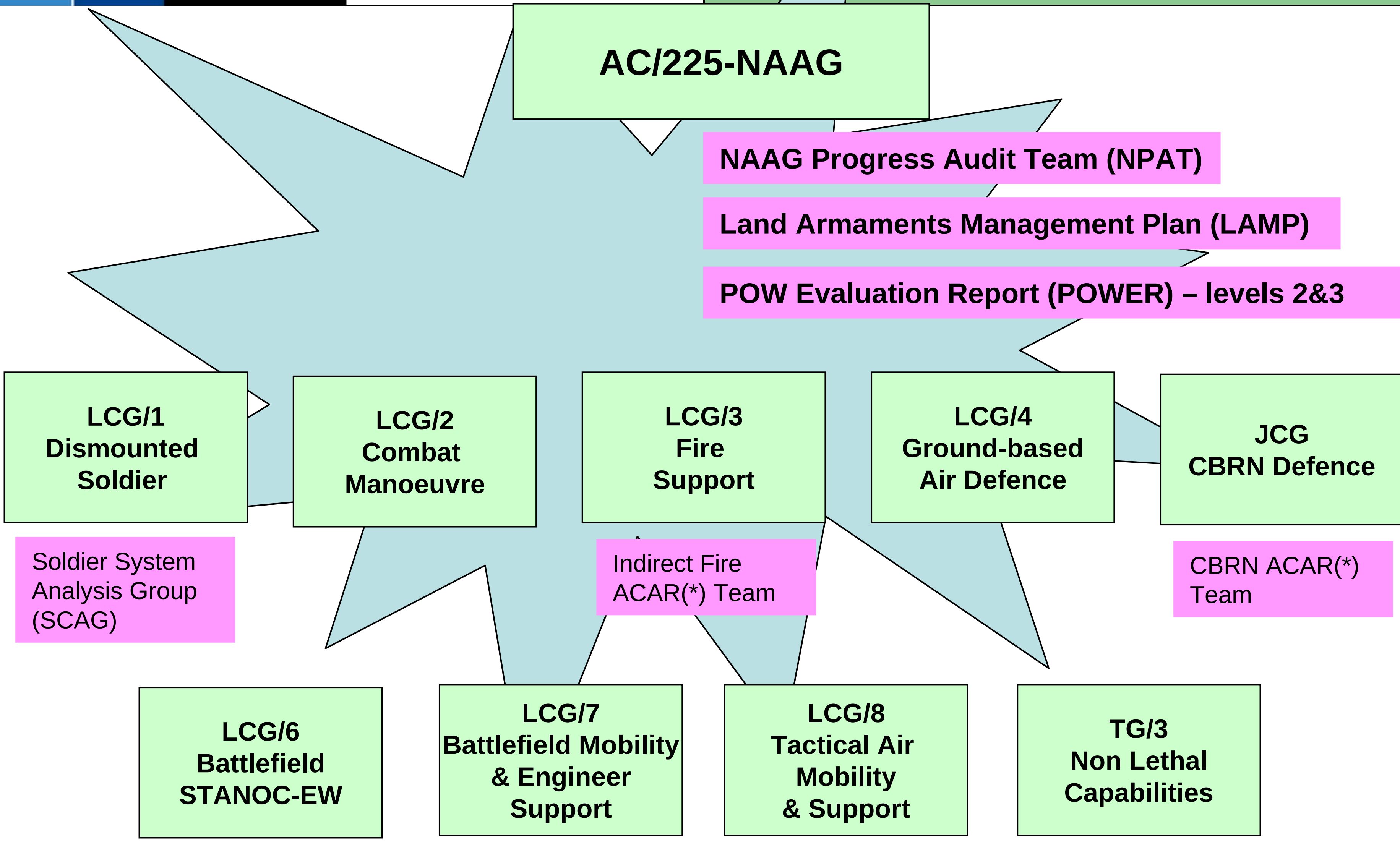
Topical Group 3 on Non Lethal Capabilities
Update Brief to NDIA

Liliana McShea
Chairman Topical Group 3

Topical Group 3 on Non Lethal Capabilities



Topical Group 3 on Non Lethal Capabilities



- The NAAG and its sister Armaments Groups for the Navy and Air Force make up the Council of National Armaments Directors (CNAD) reporting to the North Atlantic Council.
- The NAAG is made up of senior national military planners, with the Chairman position rotating among member nations
- The work of the NAAG is accomplished by nine direct reporting groups and a Topical Group
- TG/3 is a temporary, level 2 group with a mandate of 5 years. It is open to all NATO members and Partners for Peace nations. TG/3 normally meets twice a year

Area of Responsibility:

- The NATO Army Armaments Group (NAAG) focal point for all Non-Lethal (NL) activities…

Mission:

- …strive to significantly improve NATO and Partnership for Peace (PfP) NLC across the full spectrum of operational requirements, mission areas, and operating environments in order to achieve a better understanding and interoperability within NATO.

NATO TG 3 – NLC TASKS

- Follow on the directions of the NAAG QRT on NLC.
- Maintain and expand the current NAAG NLC catalogue.
- Proceed with a capability gaps analysis on NATO NLC in the short, medium and long term; formulate recommendations to the appropriate NATO body, as required.
- Support CNAD DAT program of work, if applicable.
- Coordinate all NLC efforts within the NAAG.

NATO TG 3 – NLC TASKS (Cont.)

- Formulate STANAGs for the standardization of NLC within NATO.
- Act as the NAAG liaison with other NATO NLC related organisations as required.
- Maintain an overwatch on MOUT activities within the NAAG and formulate recommendations as required.
- Continue monitoring the work conducted under Five Powers Working Group (5PWG) on MOUT and act as a conduit for this group's products to NAAG.

TG/3 Program of Work (POW)

		2007		2008				2009				2010				2011
	Lead	3*	4	1*	2	3*	4	1*	2	3*	4	1*	2	3*	4	1*
MOUT Effort Reduction																
"MOUT Overwatch"																
Identification of Relevant NATO Bodies																
Liaison with Relevant NATO Organizations																
Review of Past and Current NLW Efforts and Validation of QRT Results																
NLC Definition(s) Articulation																
Identify/Modify NLC-based Tasks List																
Deduct desired Effects from Task List																
Identify NLC Requirements																
Identify List of Required Capabilities																
Identify Gaps																
Prioritize Gaps																
DOTMLPFI Analysis																
DOTLPFI																
M																
Assess the impact of New NLC																
Effort Coordination with ACT																
Develop Plan (with RTO / NIAG) to resolve gaps.																
Standardization Opportunities																
Support [potential] DAT on NL Initiative																
MOE / MOP Development																
Collaborative Effort with RTO (SAS-060 Results)																
Expand and Maintain NLC Catalogue																
Review of TG3 Program of Work & Terms of Reference																
National Information Exchange																
NLC Relevant Demonstrations																
Doctrine and Concept																
Lessons Learned																
Projects / Activites																

NATO NLC PROPOSED DEFINITION

A capability, designed and expected to achieve a relevant military effect on a person, equipment or infrastructure yet with a significantly lower risk of human fatality or permanent injury than could be expected from conducting the same task through the use of conventional systems (i.e. those designed with a high probability of lethality).

WHAT IS NOT A NLC

- Any other capability not designed specifically for the purpose of minimizing fatalities, permanent injury to personnel, and undesired damage to the environment…

For example:

- Information & Psychological operations;
- The use of smoke and illumination on the battlefield;
- Electronic Warfare, including jamming and/or counter-IED protection;
- Systems designed to minimize collateral damage;
- The use of lethal assets in a non-lethal manner; and
- Personal Protective Equipment (PPE) and other equipment designed to enhance survivability.

Way Ahead

- Identified NL mission tasks for coalition forces
- Establish Teams of Experts/Sub-Groups to sub-divide the tasks.
- Establish a reliable website to share information with other NATO and Partners for Peace entities.
- Establish a reliable mechanism within the NAAG in order to pull/push NLC requirements.
- Establish a Point of Contact with NATO Lessons Learned.
- Next meeting schedule at NATO HQ 8-9 September 2008.

QUESTIONS ?

Program Objectives

In support of PM-MAS and JSSAP development programs:

- Determine the viability of using FEA as a tool for **predicting** small arms ammunition terminal ballistic performance

- **Evaluate** the effectiveness of various small arms projectiles, after they have penetrated through metal barriers

- Determine the viability of using FEA as **developmental tool** for small arms ammunition and weapon system development

"Lethality"

"Lethality"

Target Reaction to Hit

Bullet-Target Interaction
- Location of hit
- Target Composition
- Projectile Ballistics

Probability of Hit

Project Focus

Probabilities

Incapacitation

Warfight Actions

Target Actions

Approach

Create Model

- Diverse projectile configurations and calibers evaluated
  - M855, MK262, M995, M855/.265, M855/.308, M855/Pb, M855/Al, M855/ WC
  - Targets: 1/8” Mild Steel, 3/8” Mild Steel, ¼” RHA. ¼” RHA 30 ob
- Material research

Simulate effectiveness

1. Use FEA to Simulate ballistic impact with barrier material
2. Use CFD* as well as analytical means to determine post-barrier projectile drag mechanics
3. Use FEA* as well as analytical/empirical models to simulate the impact of the post-barrier projectile into ballistic gelatin
4. Use physical/empirical models quantify the potential effectiveness against a human target

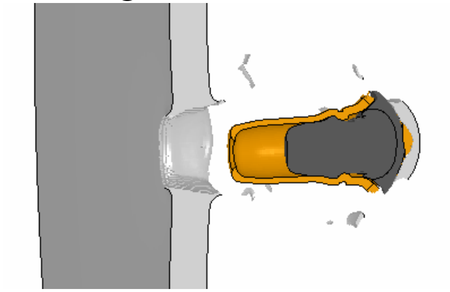
Evaluate

- Briefly compare effectiveness variations against user needs

* On going efforts

Technical Background

1) LS-Dyna impact model generates mass, velocity, shape and orientation of projectiles after passing through a barrier.



2) LS-Dyna output put into Sturdivan-Bexan equations to predict subsequent yaw history in 20% gelatin. Simultaneously, LS-Dyna output with Surdivan-Bexan yaw history placed into Peters equation to predict velocity decay in gelatin

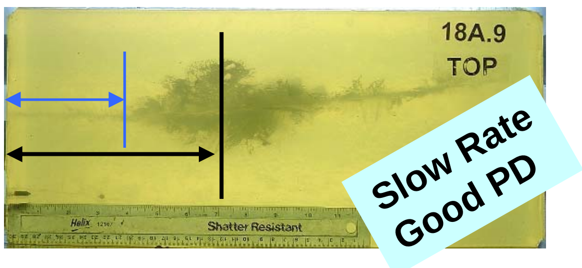
$$V(x) := \sqrt{V_o^{2} \cdot \left[\left[1 + \left(\frac{a \cdot U}{V_o} \right)^2 \right] \cdot e^{\left(-\frac{\rho \cdot C_D \cdot A}{m} \cdot x \right)} - \left(\frac{a \cdot U}{V_o} \right)^2 \right]}$$

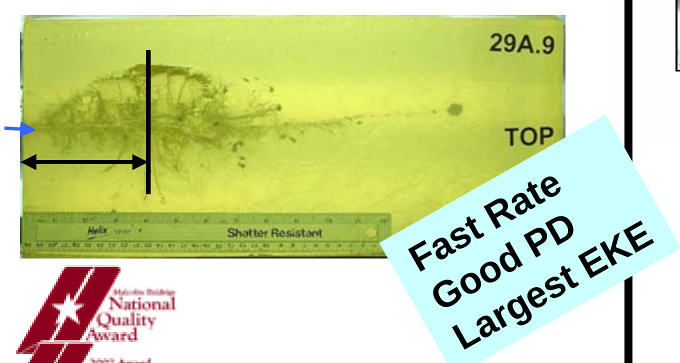
3) Velocity decay information, as well as retained mass from LS-Dyna used to feed EKE equation, providing the final estimation of effectiveness in the human Thorax.

$$EKE = \frac{m}{2} \sum_{x} Pi(\Delta V)^2$$

Damaging Soft Targets

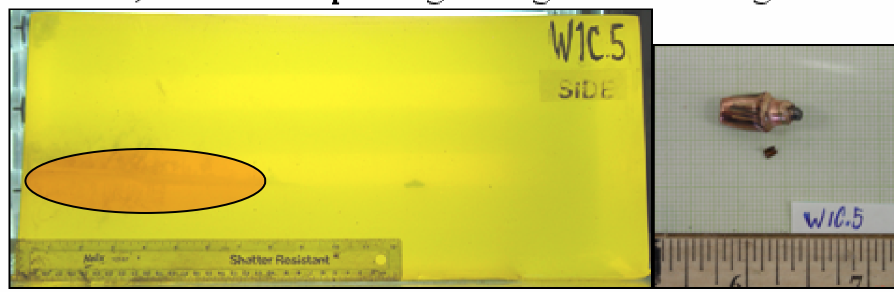
Energy Deposit rate
and penetration depth





Post Barrier Damage, as a result of projectile mass

5.56mm, M855 after passing through windshield glass into gelatin @ ~ 2700fps



7.62mm, M80 after passing through windshield glass into gelatin @ ~ 2700fps

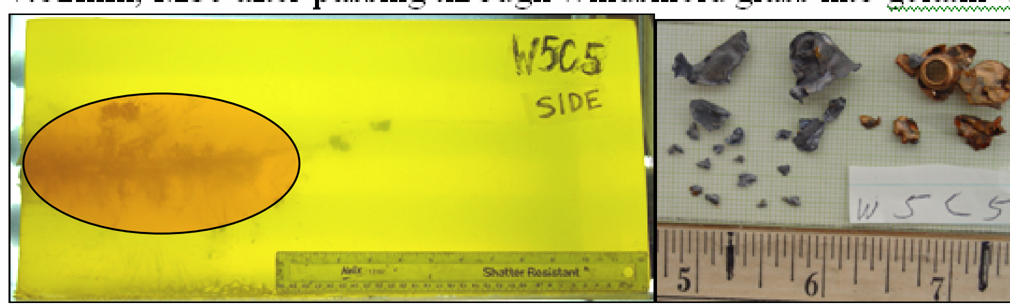
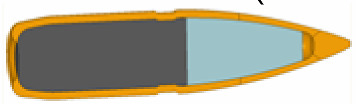
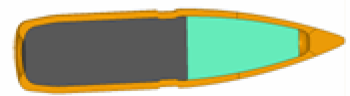
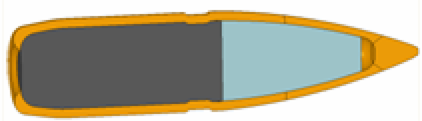
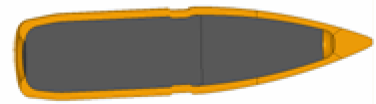
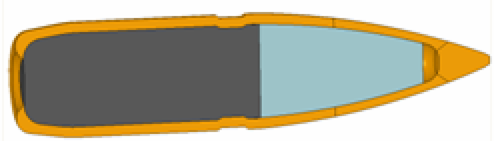
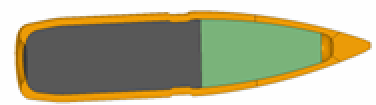
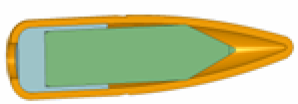
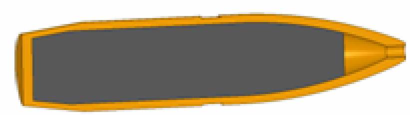


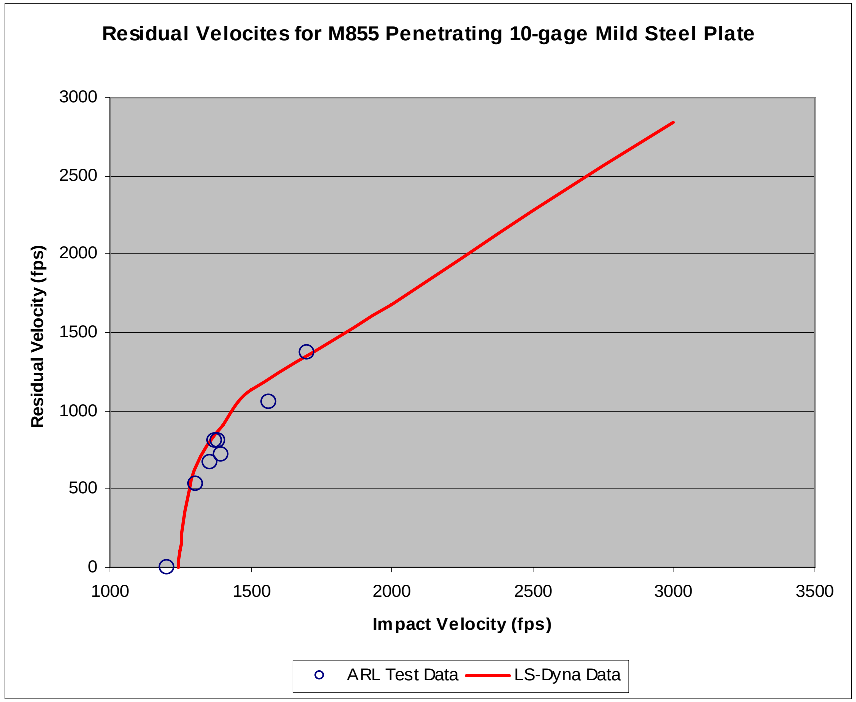
Figure 5. M855 vs. M80 through Auto Windshield

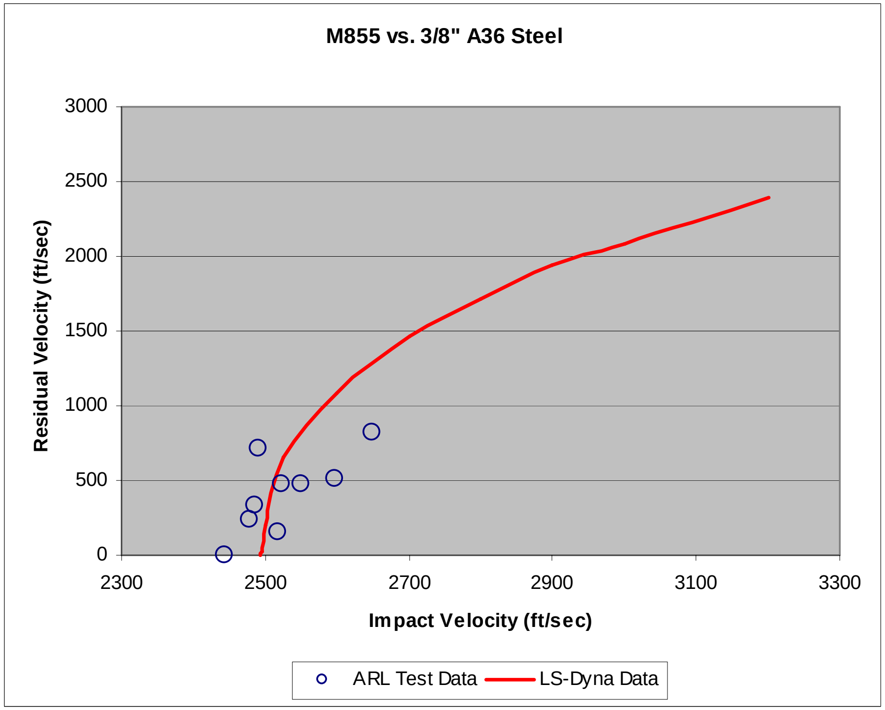
Remember…"Ballistics vs. Logistics"

Candidates for Study

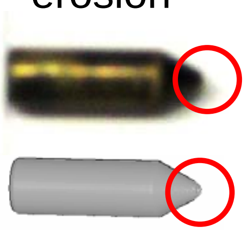
M855, Nominal (.223 cal)  FMJ; 62.6 grains; Steel penetrator backed by lead core encased in copper jacket	**M855/AL-pen**  FMJ; 56 grains; Aluminum penetrator backed by lead core encased in copper jacket
M855/.265 cal  FMJ; 109 grains; Steel penetrator backed by lead core encased in copper jacket	**M855/Pb-pen**  FMJ; 67 grains; lead penetrator backed by lead core encased in copper jacket
M855/.308 cal  FMJ; 171 grains; Steel penetrator backed by lead core encased in copper jacket	**M855/WC-pen**  FMJ; 78 grains; Tungsten Carbide Penetrator backed by lead core encased in copper jacket
M995  FMJ; 53 grains; Tungsten-Carbide penetrator centered with an aluminum cup encased in copper jacket	**MK262**  OTM; 77 grains; All lead core encased in copper jacket

Baseline

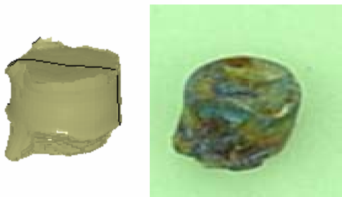


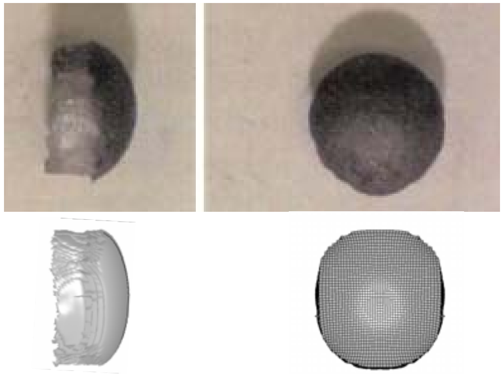


M995 tip erosion



M855 penetrator deformation

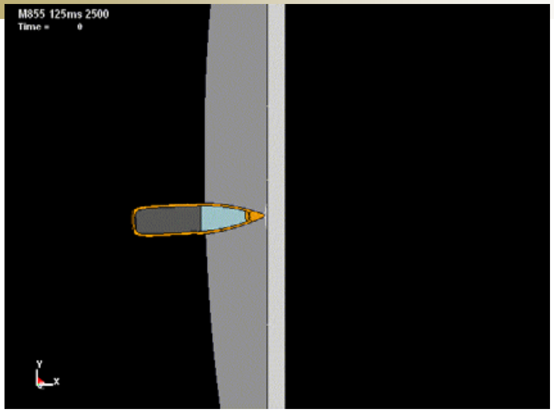




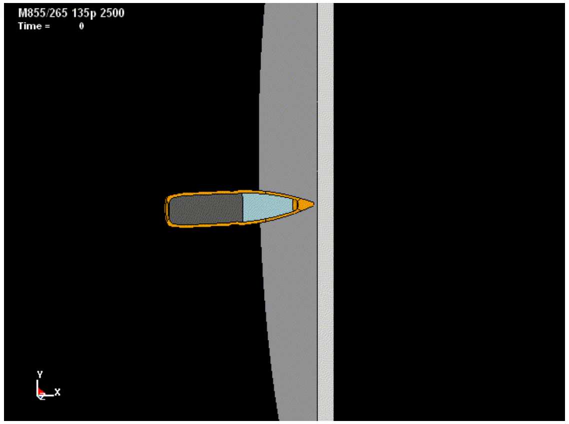
Plug from MK262

Simulations: 1/8” mild steel, 2500fps

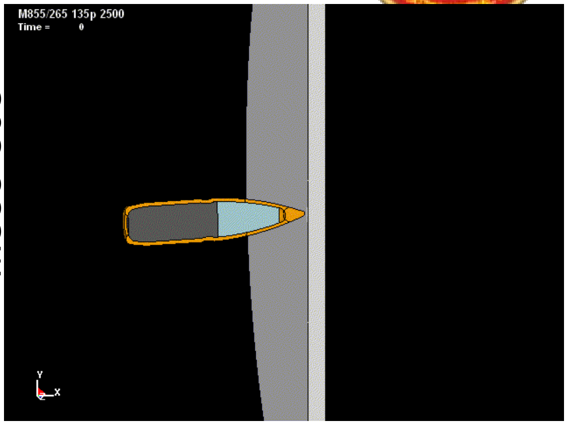
M855



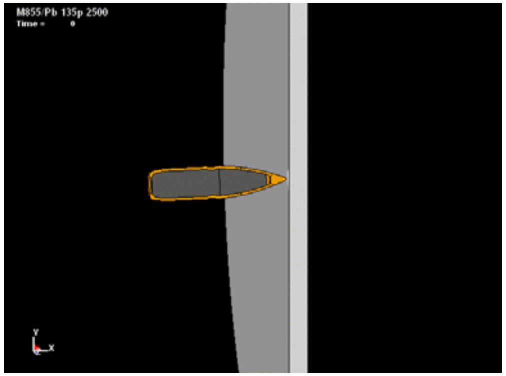
M855-265



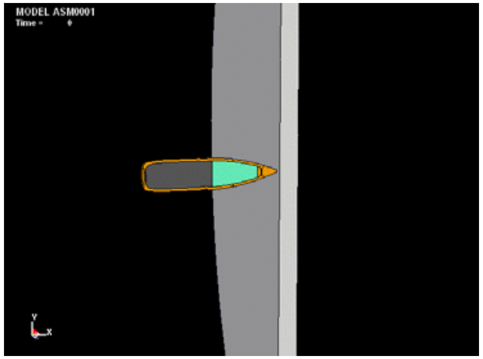
M855-308



M855-PB

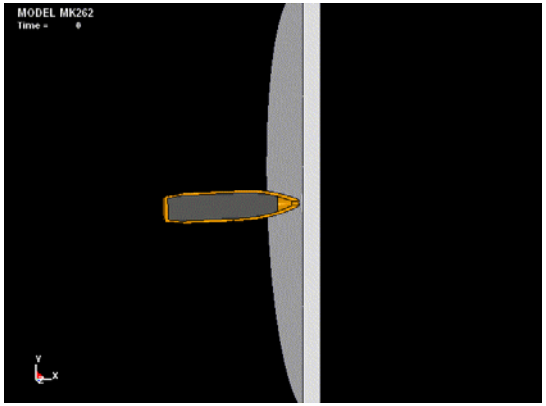


M855-AL

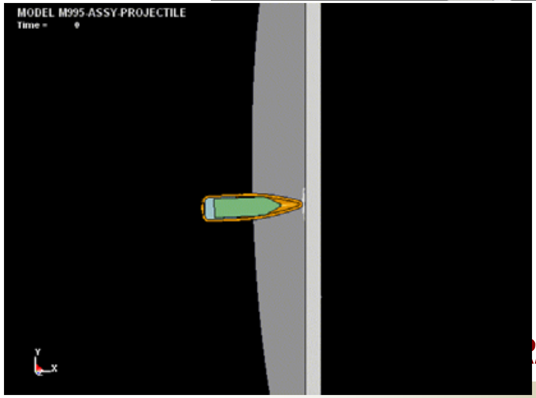


M855-WC

MK262

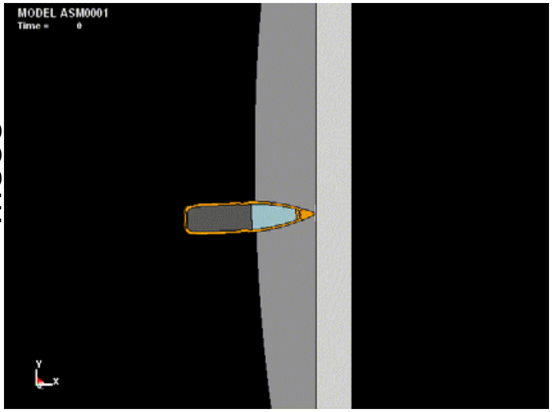


M995

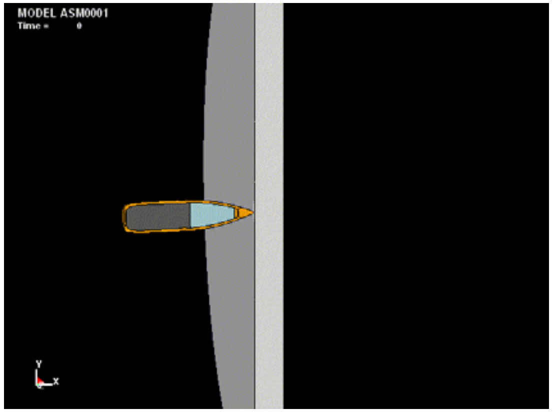


Simulations ¼” RHA, 3000fps

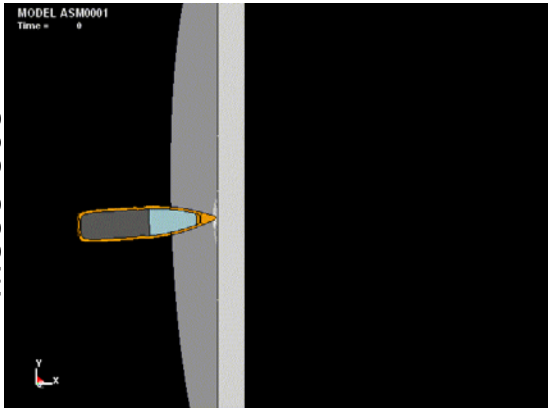
M855



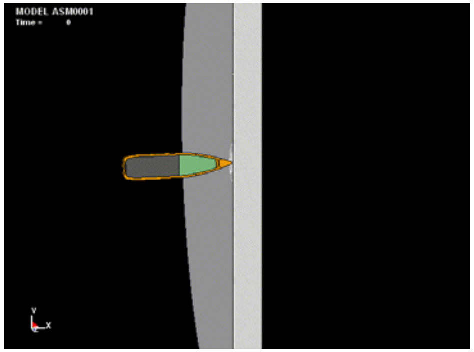
M855-265



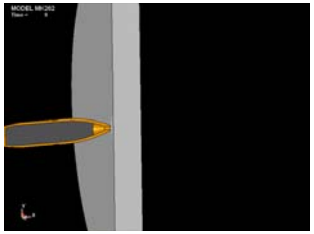
M855-308



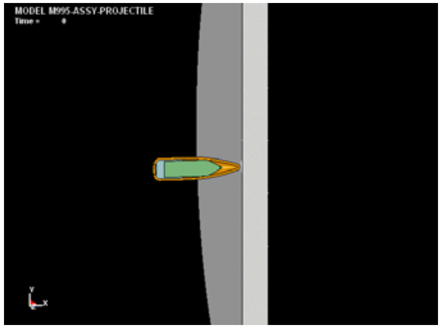
M855-WC



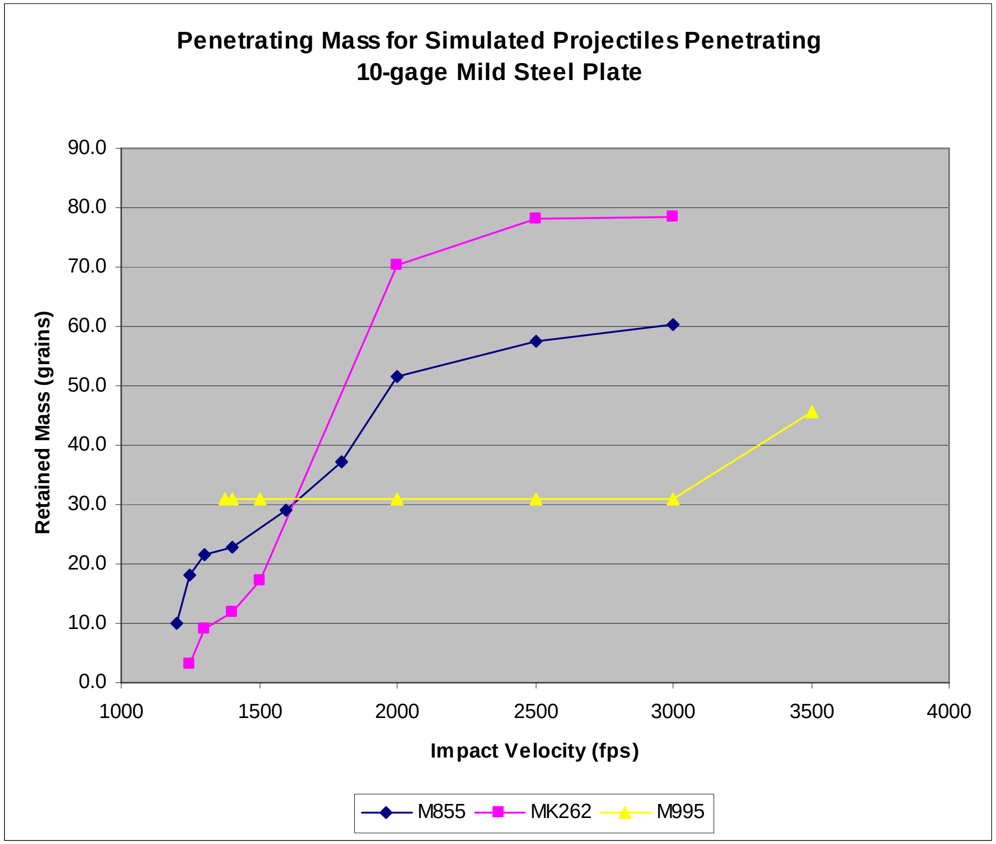
MK262

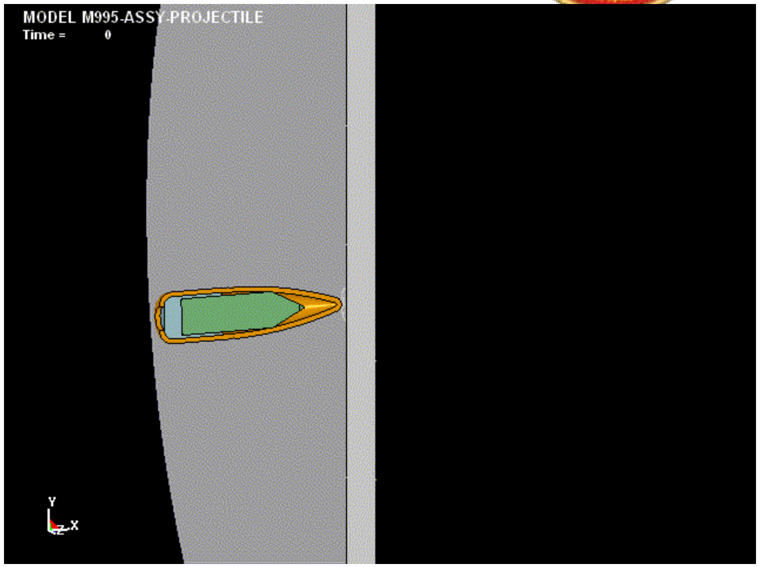


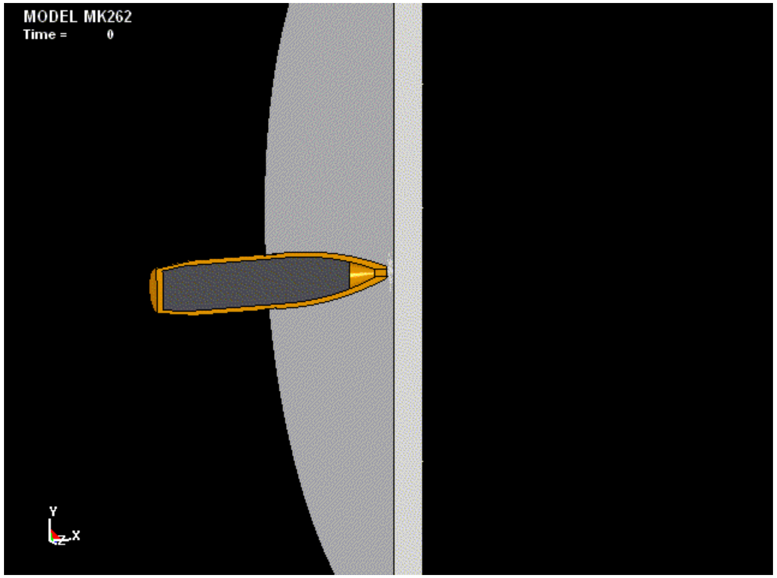
M995



Retained Mass





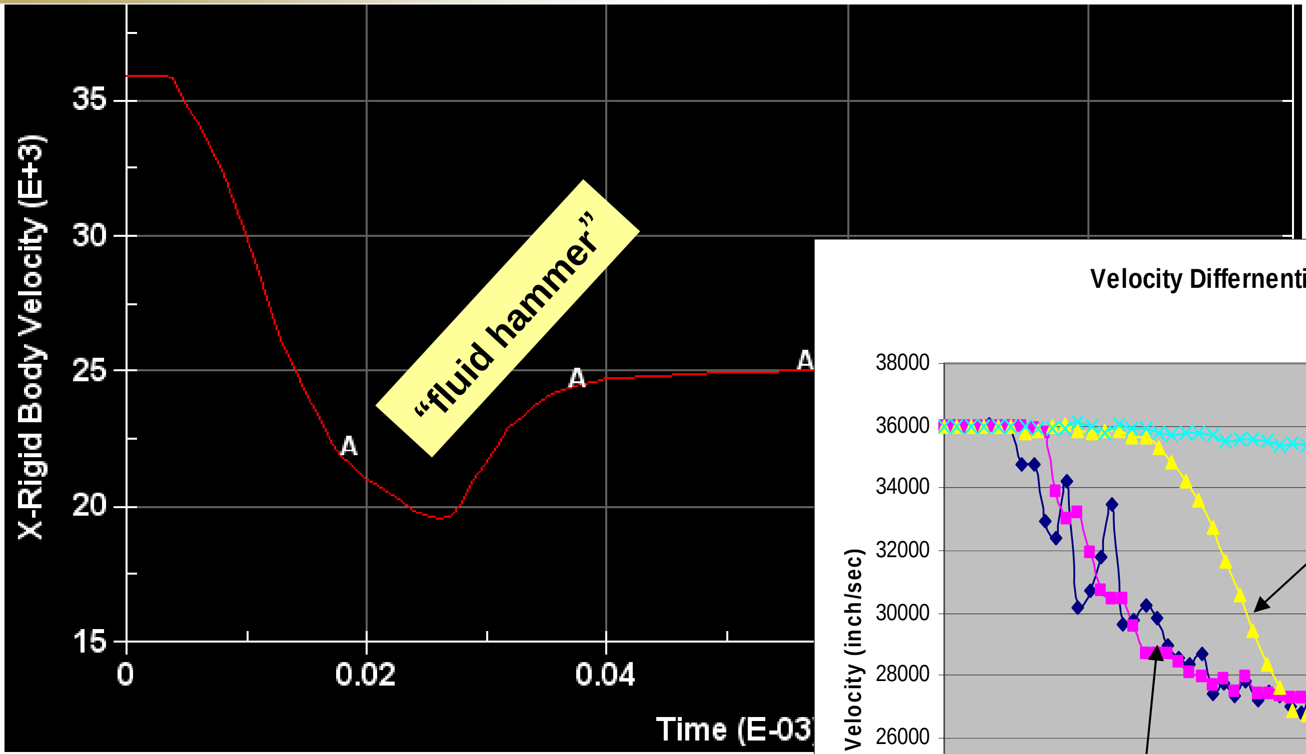


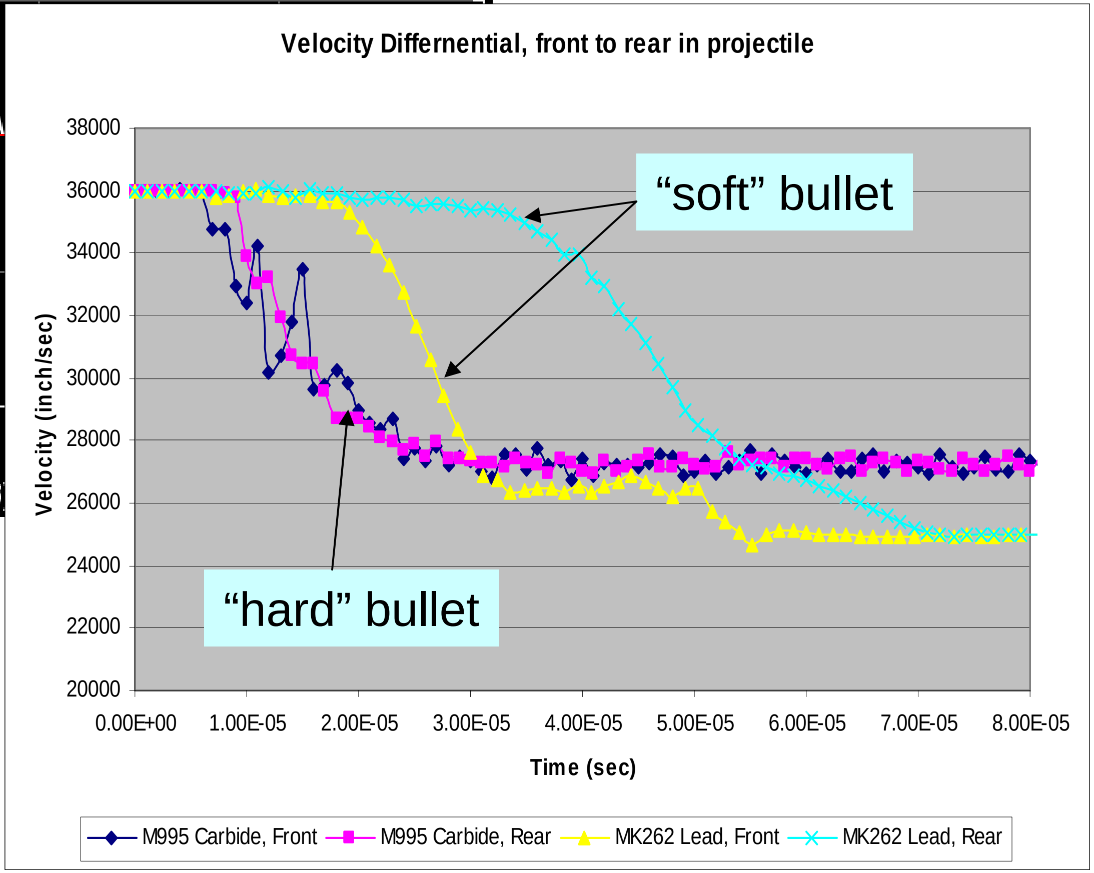
Recall…

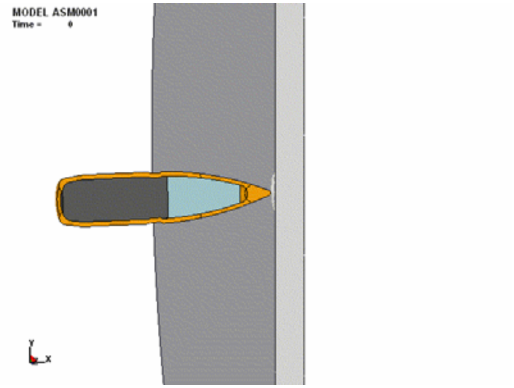
$Mv^{3/2}$

$$F = \frac{1}{2} C_D \rho V^2 A$$

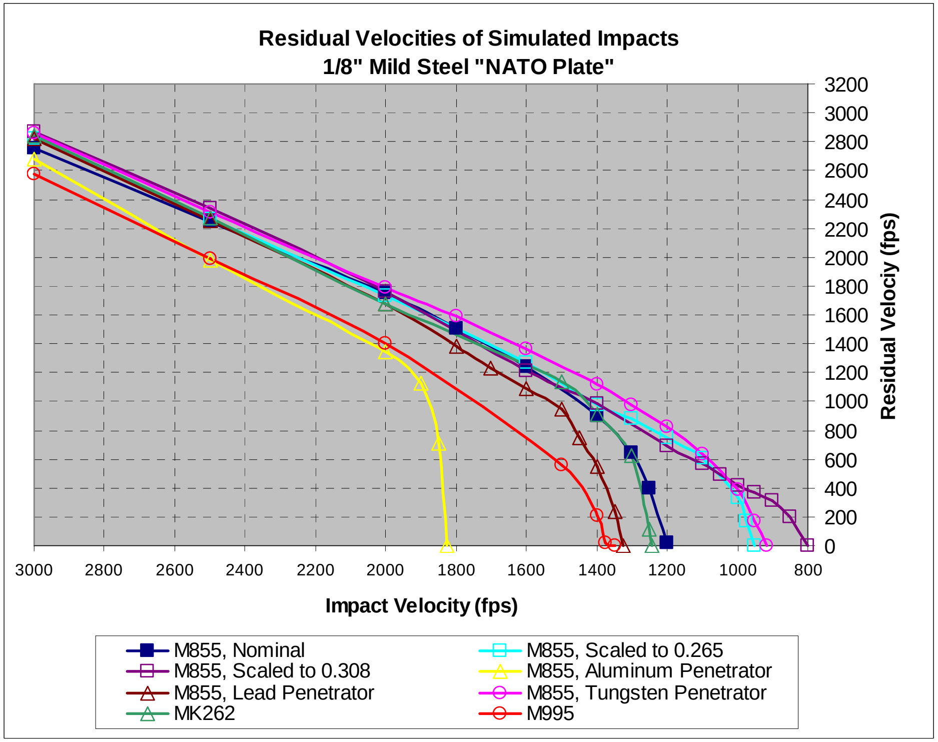
Velocity Increase?

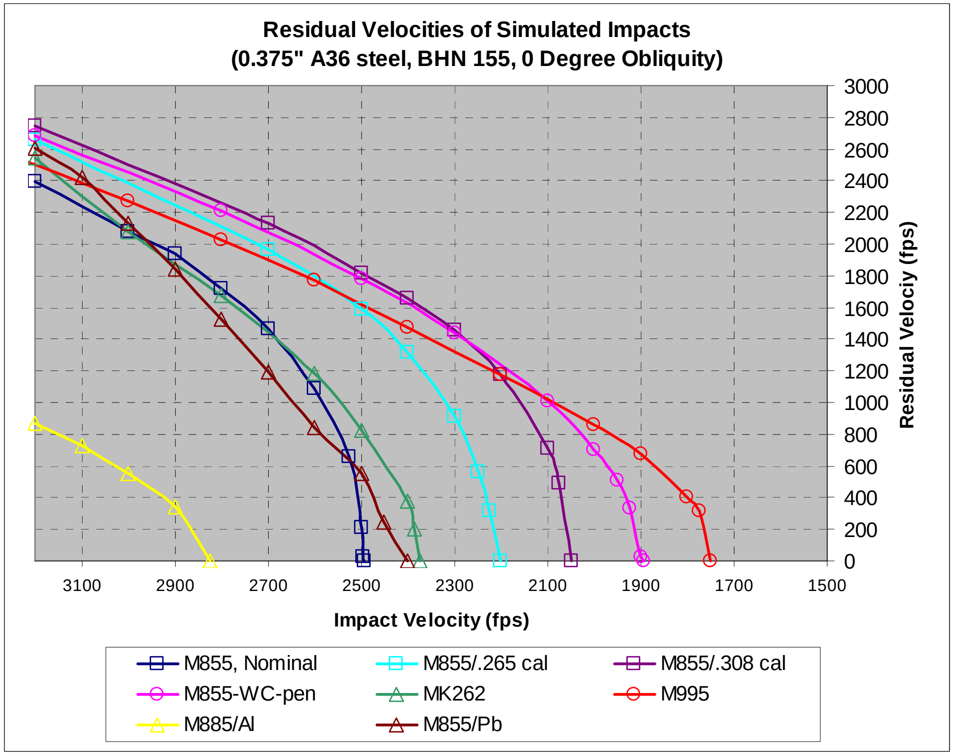






Compiling the Simulated Results





Heavier projectiles have lower V50's and carry more mass through lighter barriers

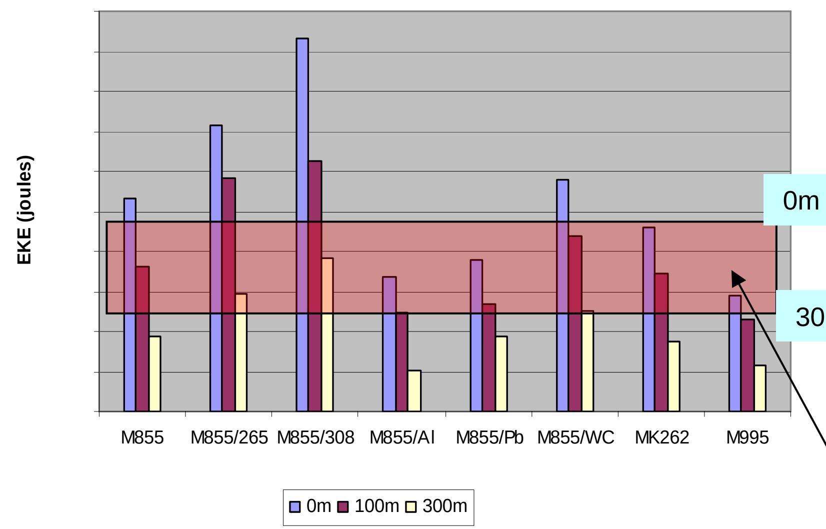
Harder targets to defeat will push user towards AP type ammo

Evaluating the Results by **RANGE**

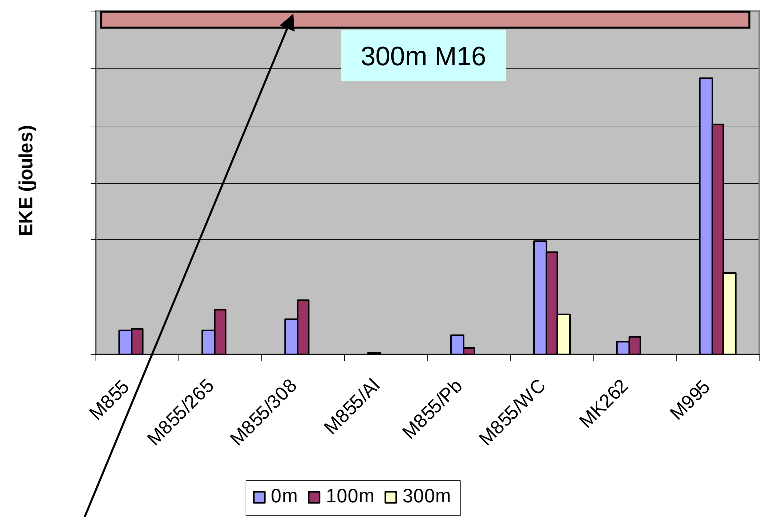
Effectiveness at a given RANGE is more useful to the user…

M995 penetrates when others cant…
…but how effective is it after the barrier?

Effectiveness after 1/8" Mild Steel
Zero to 300m



Effectiveness after 3/8" Mild Steel
Zero to 300m

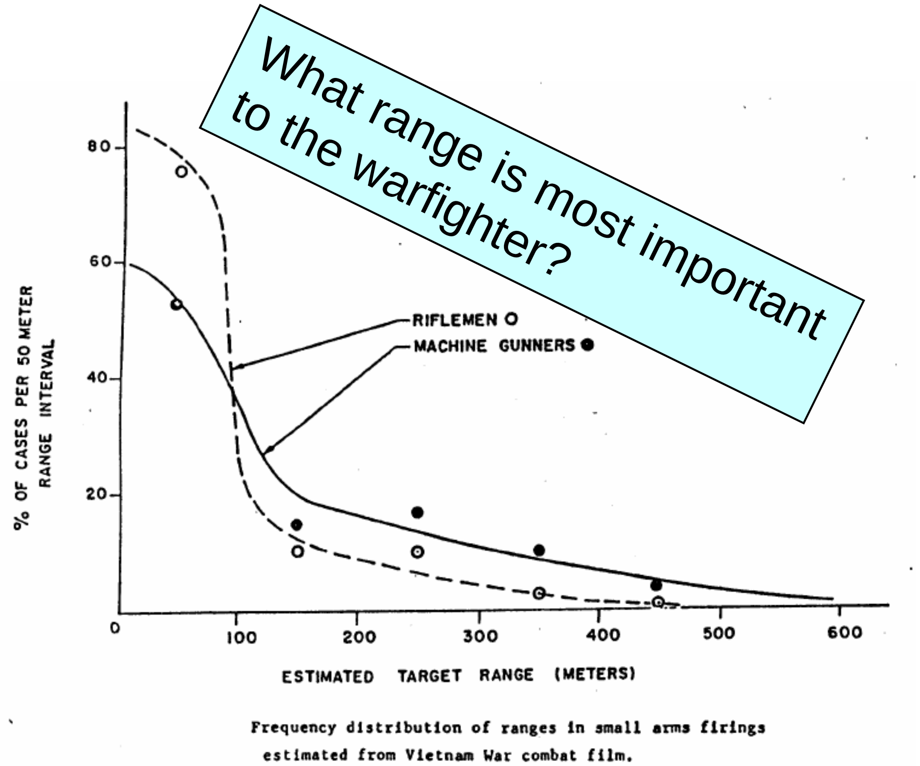


M855 better thru plate than on bare at close range?

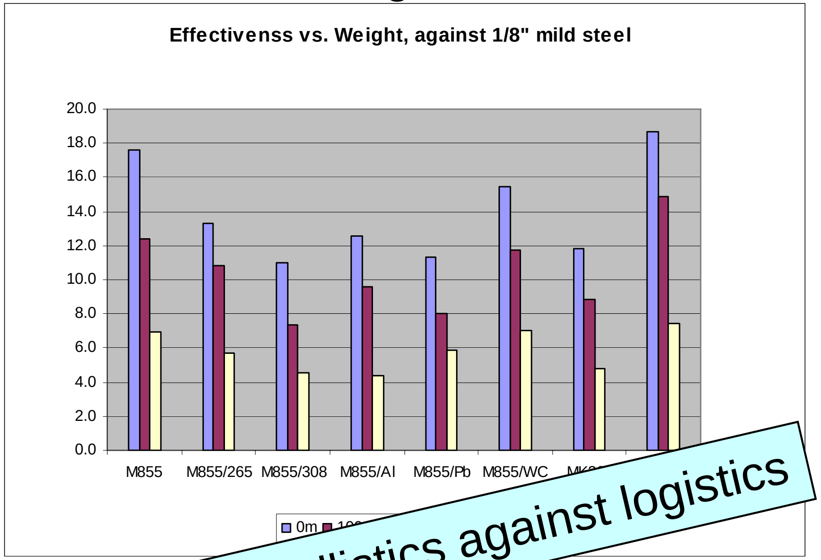
M16/M855 EKE, no barrier

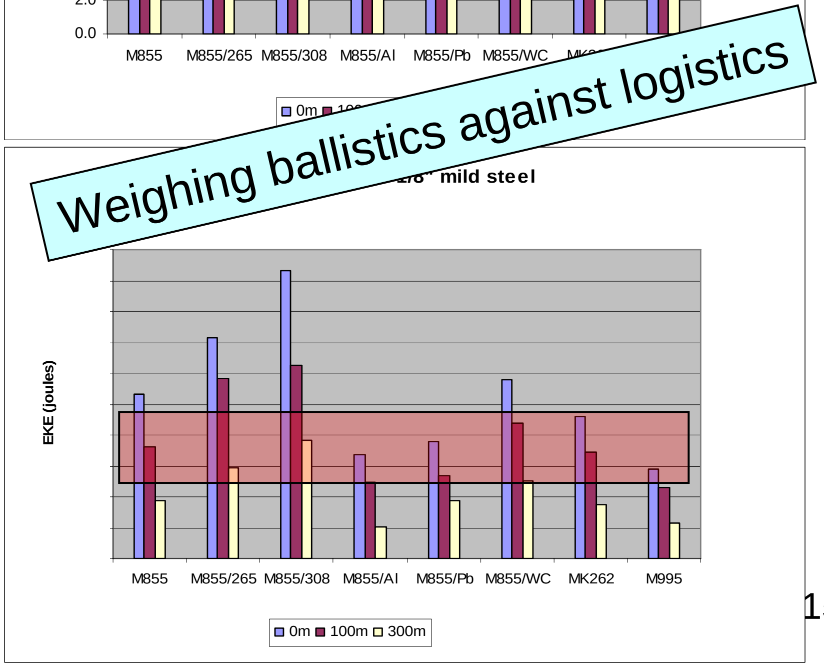
Trade Offs

Requirement



Weight





Summary

Qualitative look at top 4 candidates against each target

1/8” Mild Steel	3/8” Mild Steel	¼” RHA
M855-.308 caliber	M995	M995
M855-.265 caliber	**M855-WC-pen**	**M855-WC-pen**
M855-WC-pen	M855-308.cal	M855-.265cal
M855	M855-.265 cal	M855

MK262, M855-AL, M855-PB all significantly lower overall

Requirements + Performance + Trade-space + logistics = Choice

Conclusions

- Simulations correlate well, in most cases, to test data
  - Limit velocities for M855 against RHA, and Mils Steel matched ARL test data
  - All lead bullets may require fine-tune
  - ¼" RHA material properties may require fine-tune

- Simulations can be used to improve the projectile development process
  - Simulations show sensitivity to geometric and material property changes
  - **Simulations enable comparative, scientific analysis**
  - 100% predictive capability still difficult without calibrating test data
  - **Simulations reduce product development time**
  - **Simulations improve product quality**

- Putting a harder penetrator in the M855 is a good overall improvement

- Intermediate caliber can balance range with penetration capability effectively

Mission Payload Module
Non-Lethal Weapons System

briefing for

National Defense Industrial Association
Small Arms Systems Symposium
19-22 May 2008

Victor Dodson
Team Leader
Non-Lethal/Force Protection
Marine Corps Systems Command

What is needed?

Operational Forces Requested a Non-Lethal System That:

- Provides a Counter-Personnel Capability That Complements Lethal Weapon Applications and Effects
- Provides Marines With a High Volume of Fire, Extended Range and Incapacitation Capability
- Reduces or Avoids Risk of Permanent Injury to Personnel and Unintended Destruction of Equipment or Infrastructure

What is MPM-NLWS?

MPM-NLWS is a *new Weapon System* That Launches Non-Lethal Payloads to Greater Ranges, With a Broader Area Coverage, Greater Duration of Effects and High Volume of Fire

The MPM-NLWS Will:

- Initially be Deployed From the HMMWV (or its Replacement)
- Deliver Counter-Personnel Non-Lethal Effects Applicable to Controlling Crowds, Denying / Defending Areas, Controlling Access and Engaging Threats
- Incapacitate its Intended Targets, Which is Disable, Inhibit or Degrade one or More Functions or Capabilities of the Targets to Render Them Ineffective
- Provide Increased Standoff Distance for the Protection of Friendly Forces

MPM-NLWS Program Overview

2008
Technology Demonstration

- **The Technology Demonstration Phase**
  - One year demonstration phase leading into RFP for System Development & Demonstration Phase
- Objectives of the Technology Demonstration Phase
  - Demonstrate alternative technologies for MPM-NLWS
  - Demonstrate payloads
- Results will inform SDD RFP and support assessment of current technology

2009-2011
System Development and Demonstration

- **The SDD Phase**
  - Up to Three-year effort to develop, integrate, and demonstrate an integrated system that satisfies the Capabilities Development Document
  - Leads into a Capabilities Production Document and the RFP for production systems

2012- 2014
Production

- **The Production Phase**
  - Multi-year effort to produce the MPM-NLWS and provide it to the warfighters
- Objective of the Production Phase
  - Provide an integrated system that satisfies the CPD attributes

Number of contracts for the SDD Phase has not been determined

FY08 Program

Industry Demonstrations

- Results of Market Research Indicated That a Mature Technology Base (TRL-6) Exists
- Several Developed Systems Purport to Already Achieve Many of the Required Capabilities
- Goal is to Leverage Industry's Investments and Government's Preference for Mature Solutions

Demonstrations Will Take Place During September 2008

- Currently in Source Selection for the Demonstration Contracts
- Demonstrations Will Inform Decisions for SDD Phase Contract (s)
- Vendors do not Need to Participate in the Demonstrations to bid on the SDD Phase

You do not need participate in the demonstration to bid for the SDD contract(s)

Current Challenges

Issue: Industry has Limited Payload Expertise and is Required to Develop a Non-Lethal Payload That can Temporarily Incapacitate a Group of Personnel While Minimizing Risk of Permanent Injury

- <u>Effect on Targeted Personnel</u>
- <u>Ranges to Target</u>
- <u>Risk of Permanent Injury</u>

Challenges:

- How Does Industry Determine if Their Payload Will Satisfy the Requirement?

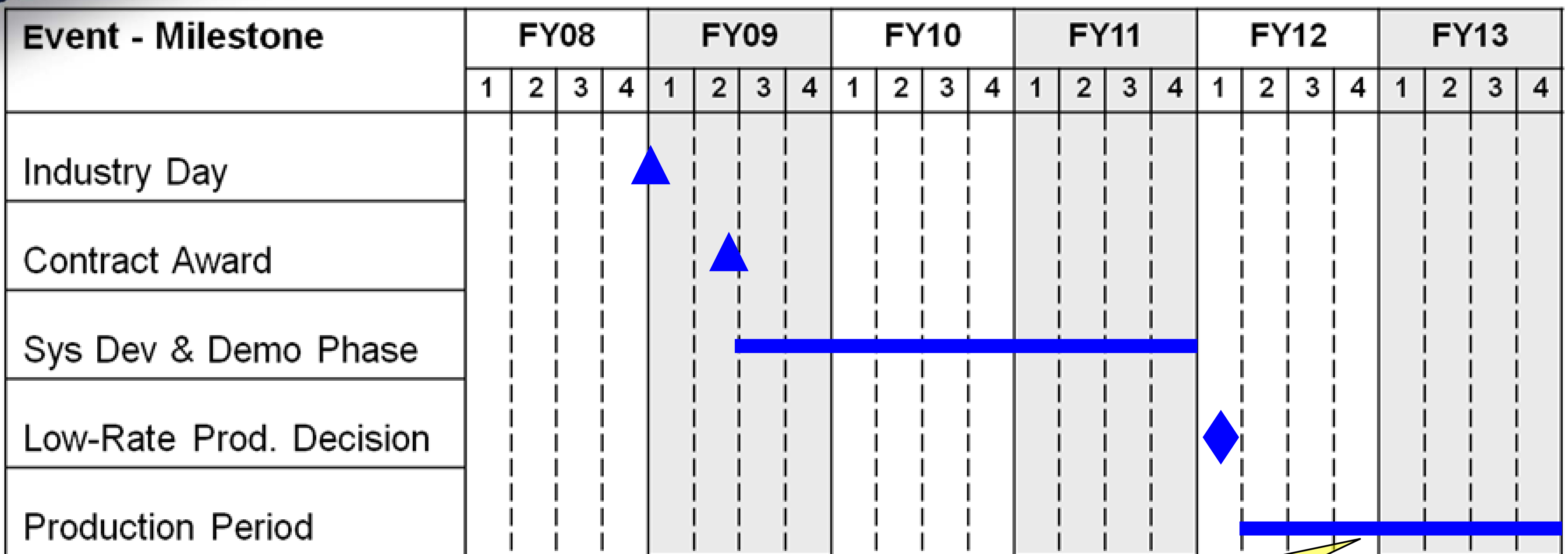
Mitigation:

- A Pre-Solicitation Industry Day Will be Held at MARCORSYSCOM Prior to Release of MPM-NLWS SDD RFP

Anticipated Navy Electronic Commerce Online and Federal Business Opportunities Posting in September 2008

Selection of an effective payload is critical to a winning MPM-NLWS

Schedule



Approved USMC (Spiral One) Acquisition Objective: 312 Systems
Working for Army/Navy for Spiral Two

SDD Phase Will be Open to all Bidders

How can industry Help Non-Lethal Systems / Force Protection Programs?

Develop a non-lethal system (launcher and payload) that reduces the risk of permanent injury while maximizing incapacitation and duration of effect

Questions?

DEFENCE R&D DÉFENSE

Canadian Small Arms Demonstration Project

Mr. Paul Harris, Mr. Gilles Pageau,
LCol Mike Bodner, LCol. Jacques Levesque, LCol. Luc Angiolini

National Defense Industrial Association
International Infantry and Joint Services Small Arms Systems
Annual Symposium
May 2008

Recherche et développement pour la défense Canada
Defence Research and Development Canada

Canada

Background

Soldier System Vision of the Canadian Forces

The Soldier as an integrated weapons platform: a “System of Systems”

Background

Capital Projects and Capability Development Plan
Support the Soldier System Vision of the Canadian Forces

Today → Tomorrow → Future

ISSP

Sniper System

SARP II

Clothe the Soldier +

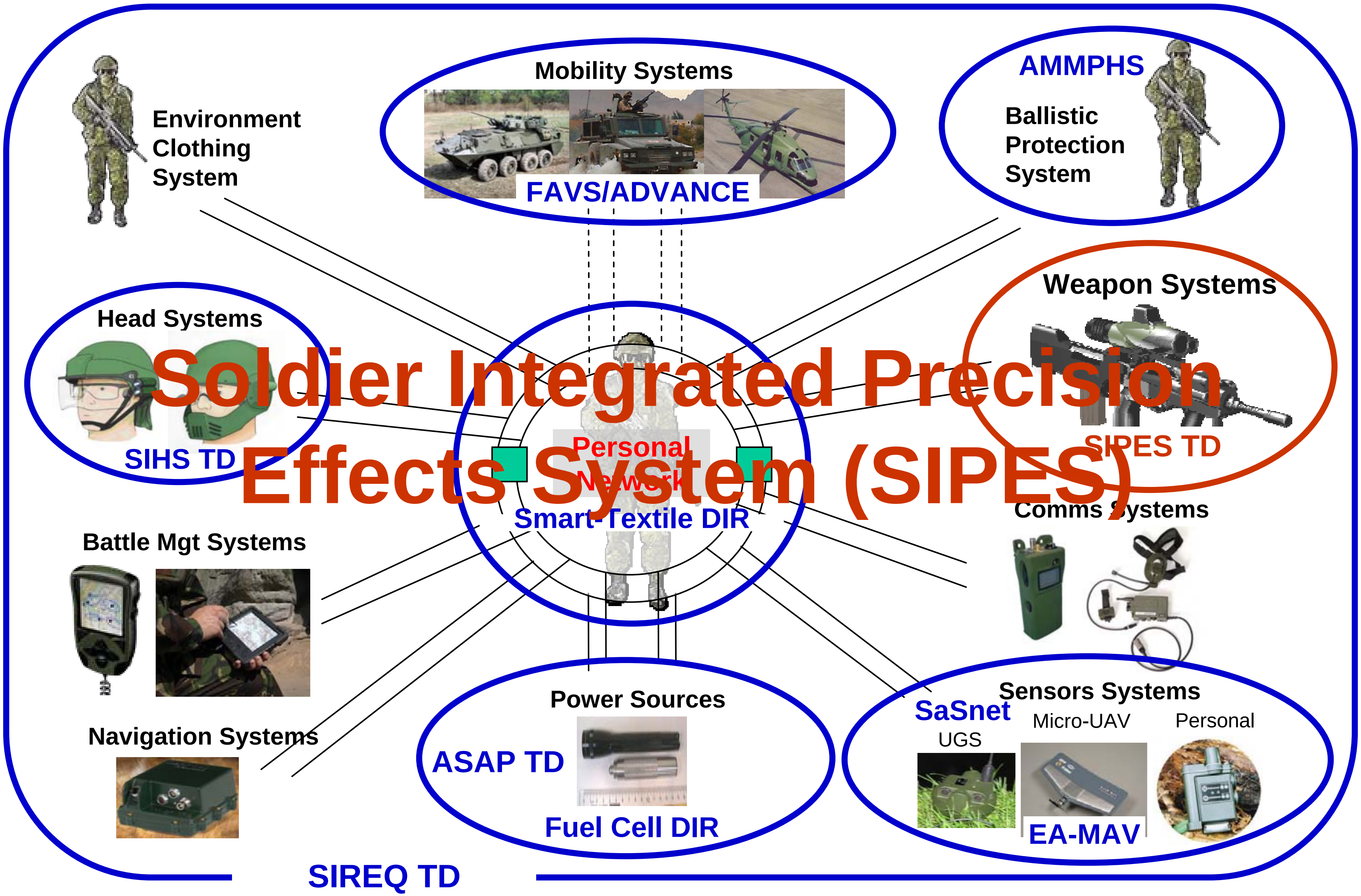
Soldier System 2020

Integrated Soldier Systems Program (ISSP)

Small Arms Replacement Project (SARP) II

Background

S&T Projects Support the Soldier System Vision



Background: SARP II

- In Oct 2007 the Options Analysis Phase of the Small Arms Replacement Project II (SARP II) was approved
- **SARP II** is a joint omni-bus project to deliver a modern, networked, integrated direct fire, multi-effect, portable anti-personnel and anti-material capability that includes weapons, fire control, munitions, training systems and logistic support for the 2012-2022 period.
- Total project cost for SARP II exceeds $1 Billion
- **SIPES TD** is relevant to SARP II immediate needs, and also has longer term applicability
(e.g.Soldier System 2020)

Background: SARP II

SARP II Capability Deficiencies

- **Lethality:** does not defeat increased personal protection
- **Ammunition:** Minimal multi-effects and few non-lethal capabilities
- **Accuracy:** Requires significant level of training for effect
- **Inconsistent Visibility:** Even with viewing aids, visibility by day/night is different.
- **Signature Management:** Noise/flash are distinctive.
- **Integration/Networking:** No direct link to the Integrated Soldier System
- **Adaptive Dispersed Operations (ADO):** Difficulty in integrating current small arms into the net-enabled and dispersed concept of ADO
- **Ergonomics:** Poor weight, compactness and operating commonality
- **Ancillaries:** Ancillaries available but not integrated.

SIPES Objective and Key Deliverables

Objective

To demonstrate the viability, utility and usability of integrated novel and high pay-off small arms related lethal and non-lethal technologies for future, lightweight, small calibre weapon systems which address current capability deficiencies

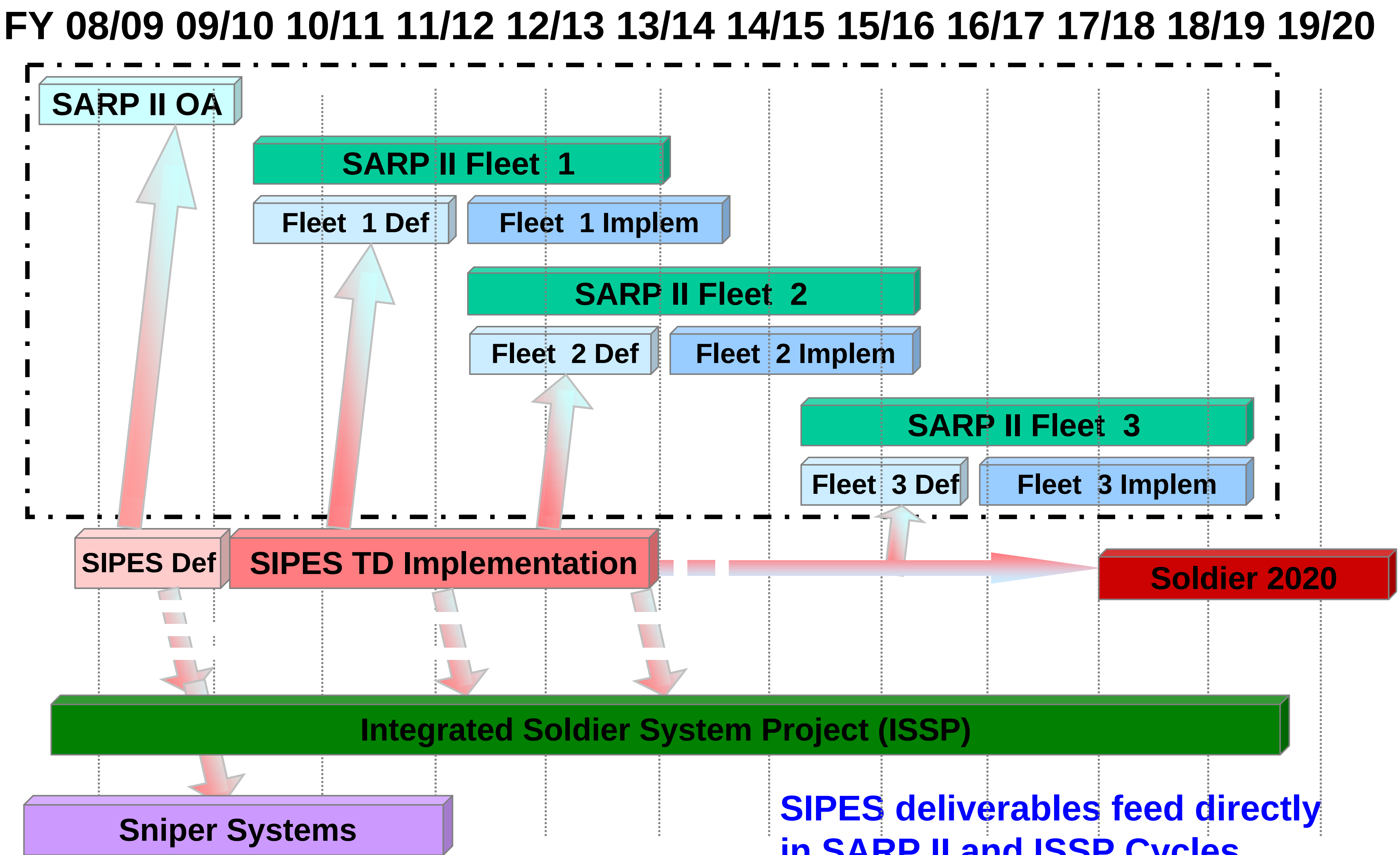
Key Deliverables

- Scientifically rigorous requirements analysis for SARP II
- Optimized soldier lethality options
- Improved weapon systems evaluation capabilities
- A future small arms R&D program plan

SIPES Vision

- Make the Army of Tomorrow (AoT) Soldier a true network-enabled precise weapon system platform with the ability for sensor to shooter linkage and the capability for applying the right effect at the right place and the right time and thus supporting the AoT force employment concept

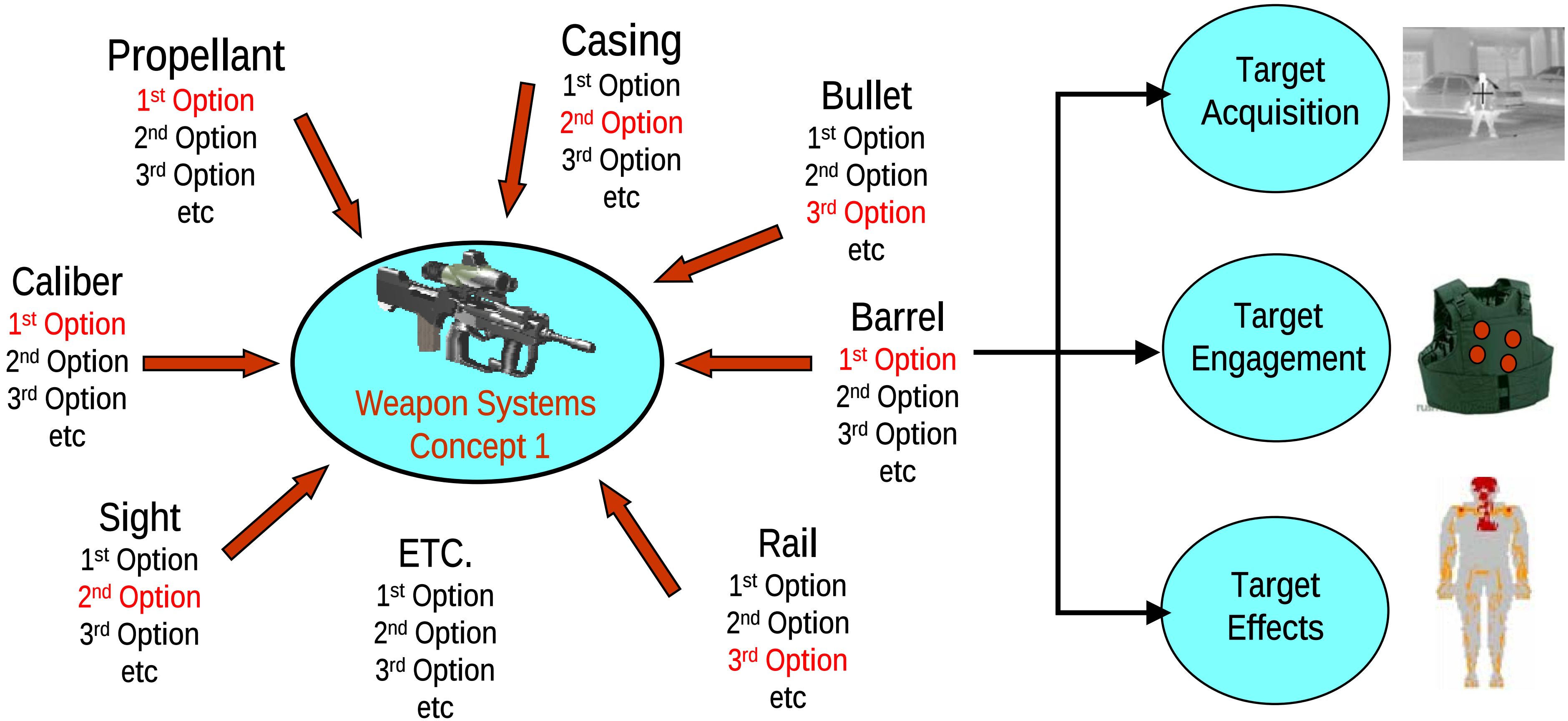
Program Relationships



SIPES deliverables feed directly in SARP II and ISSP Cycles

SIPES Concept

Small arms functional prototypes based on component technologies that are optimally integrated to maximize weapon system effectiveness. A systems approach will be used to select component technologies based on **Analytical Hierarchy Procedure** and **Human Systems Integration** principles. **Operational Analysis** will be used to predict and asses weapon systems options.



SIPES Methodology

Demonstration Level

Down Select and Spiral Off

0

Validate Understanding of the Operating Environment,
Desired Effects and Capability Gaps

Identify System Concepts for Different Fleets
and Supporting Component Technologies

PRM Decision Point

1

System Concept(s): Refinement and Simulation

Component Technologies: Simulation and Modelling

PRM Decision Point

2

Component Technologies:
Experimental Evaluation

PRM Decision Point

3

Integrated component technologies:
Static experimental test beds

PRM Decision Point

4

Functional Prototypes:
Dynamic demonstration

Demonstration Level 4

Component
Functional
Prototypes

System Functional Prototypes

Human Factors Type
Controlled User Field Trials
on
Instrumented Ranges

System Functional Prototypes:
Sample platforms for technology integration and evaluation

Developer	Designation	Description
FN Herstal (Belgium)	SCAR	Assault Rifle for the U.S. Special Operations Command
Beretta (Italy)	ARX-160	Assault Rifle for Soldato Futuro program
HK (Germany)	MP-7	4.6 mm caliber PDW
FN Herstal (Belgium)	P90	5.7 mm caliber PDW

SCAR

ARX-160

MP-7

P90

Technology Building Blocks

- **DRDC Related S&T Projects**:
  - Technology Demonstration Projects: SIREQ – Information, ASAP – Power, SIHS – Helmet, JFS – Networking, Righttrack – Green Munitions
  - Applied Research Projects: Improved penetration, I2/IR Weapons Sights, Wound ballistics, Non-lethal weapons
  - Small Arms Scoping Studies – 2005 (Jane's)
- **NATO RTO** group on Future Soldier Small Arms (interfaces, power and human factors)
- **Extensive DRDC core competencies and facilities**
- **Industrial expertise from Canadian companies and those in Allied countries**
- **International cooperation and collaboration**

DRDC Core Competencies & Facilities

Valcartier

- Wound ballistics & lethality assessment
- Aerodynamics/CFD
- Aeroballistic range
- Internal ballistics
- Energetic materials
- Green munitions
- Integration of Electro-Optics/Sensors
- Design/prototyping

Toronto

- Human Factors Design and Systems Integration
- Information Displays
- Man Machine Interface
- Interface Design
- 3D Anthropometry
- Small arms trainer

Atlantic

- Novel materials
- Material testing

Operational Research (CORA)

- Constructive simulation
- OR studies
- Gap analysis

Munitions Evaluation and Test Center (METC)

- Weapon & munitions testing

Sample Technology Area Maturity Levels

Key Technology Areas		Current TRL	Potential Goal
Weapons and Components	High cyclic rate	6	7
	Soft sensor mount	5	7
	Ceramic barrels	6	7
	Injected Metal Matrix stock	4	6
	New caliber and modular barrels	6	7
Ammunition	Caseless Telescoped	3	4
	Cased Telescoped	4	5
	High energy Nano Powder	3	4
	Green ammunition	5	6
	Segmented core bullet	2	4
	Tunable (non lethal to lethal concepts)	3	4

TRL 1	**TRL 2**	**TRL 3**	**TRL 4**	**TRL 5**	**TRL 6**	**TRL 7**	**TRL 8**	**TRL 9**
Basic research	Applied research	Applied research	Tech dev.	Tech dev.	Tech demo.	Tech demo.	System dev.	System fielding

Sample Technology Area Maturity Levels

Key Technology Areas		Current TRL	Potential Goal
Sensors and Fire Control System (FCS)	Non-conventional aiming	6	7
	Modular FCS	6	7
	Fused SWIR / LWIR sight	5	6
	Sight with Automatic Target Recognition	4	6
	Automatic tracking and firing (firing on the move)	3	5
	Energy harvesting (thermo-electric systems)	3	4
Networks and Interfaces	Wireless real-time link to soldier system	5	7
	Plug and play Ethernet based architecture	3	5
	Biometric and RFID tagging	6	7
	Power / data rail	4	7

TRL 1	**TRL 2**	**TRL 3**	**TRL 4**	**TRL 5**	**TRL 6**	**TRL 7**	**TRL 8**	**TRL 9**
Basic research	Applied research	Applied research	Tech dev.	Tech dev.	Tech demo.	Tech demo.	System dev.	System fielding

Project Status

- Project Definition Phase formally approved in March 2008
- Project Definition Phase to run from April 2008 to February 2009
- Objectives for the Definition Phase
  - Clarify Stakeholder’s Needs and directives
  - Perform high-level technology review
  - Clarify project scope
  - Obtain approval for project implementation
- Integrated technology teams have been formed
- High-Level Technology review process to be carried out by teams including personnel from government and industry
- Contractors to assist in High-Level Technology review are being identified with contracting to begin in June

Questions ??

DEFENCE R&D DÉFENSE

National Small Arms Center & National Small Arms Technology Consortium Update

Candice Campbell – Co-Chair Executive Committee

Frank Puzycki – Research Program Director

Agenda

- The “Good”
- The “Bad”
- The “Ugly”
- The Future

The "Good"

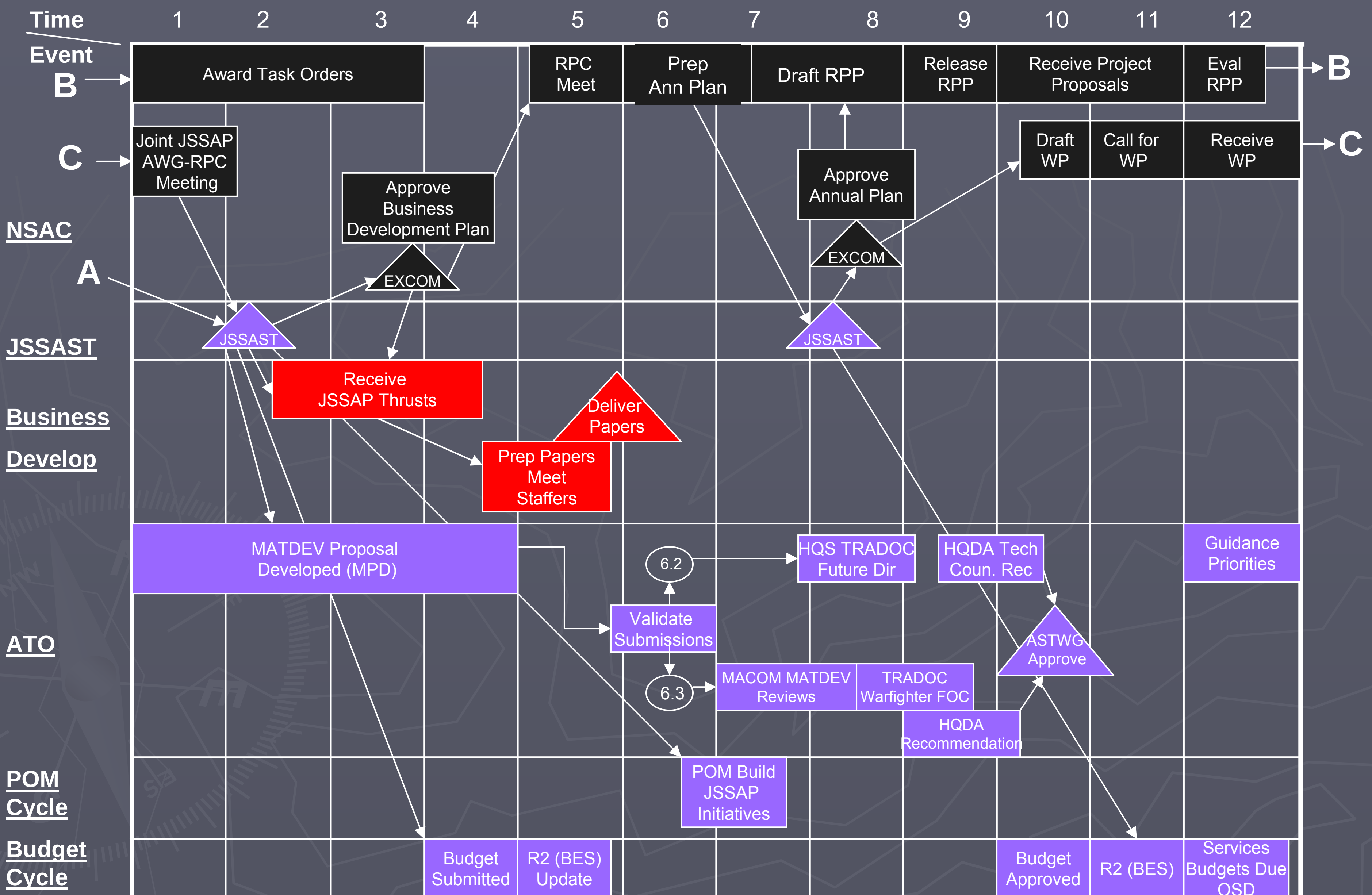
- Membership now totals around 90 firms/schools
- Business Calendar established integrating Technical, Programmatic and Fiscal elements
- FY08 White Paper Process develops new Technology Thrust
- Futures Conference lays the groundwork for a mid to long term small arms tech base investment strategy
- JSSAP Tech Base Budget now integrated into NSAC annual solicitation/budget cycle
- Industry actively engaged in concept development and governance. Website management assumed as well.

The “Good”

- FY08 Solicitation expected to obligate upwards of $4 M in new program initiatives:
  - Advanced Fire Control
  - Enhanced Lethality
  - Other
- Does not include potential ancillary PM interests
- Major FY07 Technology Achievements include:
  - Stainless Steel Case development
  - Thermal Modeling – Small Arms Weapons
  - Development of an alternate tracer concept
  - Elimination of Cobalt in Armor Piercing ammunition penetrators

FY Basis

Processes Timelines – Alternative #2

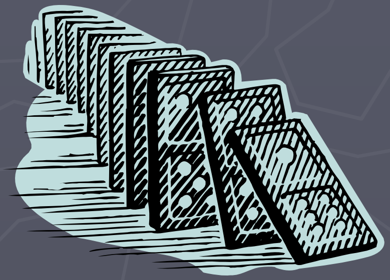


Business Cycle – Key Events

- Call for Proposals – June/July
- Proposal Response Deadline – August
- Call for White Papers – August
- White Paper Deadline - October
- White Paper Analysis – November
- JSSAST/NSATC Exec Committee Endorsement – November/December
- Handoff to NSATC Business Development Committee - January

The “Bad”

- FY08 program stalled temporarily due to Other Transaction Agreement guidance revision
  - Traditional versus Non-Traditional Member Categorization
- Domino effect in terms of program development and funding obligation



The “Ugly”

- Future operations await reformulation of OTA based organizational construct and related acquisition processes
  - Status Quo
  - Annual BAA solicitation with RPP option
  - Single Party NSATC partnership with USG in a revised OTA
- Multiple initiatives underway to clarify and resolve this matter

The Future

- Award FY08 Contract/TOSA efforts – Spring
- Semi-annual Membership Meeting at Fort Benning on June 17 and 18
- Annual Solicitation for FY09 – Summer
- Annual White Paper Call - Fall

"Follow me with Pride"

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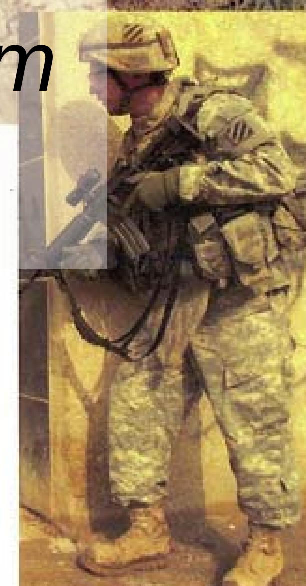
NDIA
Small Arms Symposium

COL Robert Radcliffe

20 May 2008





Agenda

- **Small Arms Capabilities Based Assessment**
- **Soldier lethality**
- **Small arms capability today**
- **Small arms capability tomorrow**
- **Strategic communications**
- **Small arms division organization**

Small Arms CBA

Process and Participation

- **Needed to establish the analytical basis for small arms requirements**
- ARCIC initiated in FEB 07
  - Study Team included broad base of knowledge and skills, significant Soldier input
  - Identify tasks, establish conditions and standards, and assess current capability against those standards to identify areas of interest
  - Assess a combination of non-materiel and materiel solutions
  - Prioritize non-materiel and materiel solutions
- ARCIC approved MAR 08

Participation in each phase of the Small Arms CBA included

User: (TRADOC Schools and Centers, 197th IN Bde, 82nd ABN, 75th Ranger)

Joint: (JSSAP, USMC, USAF)

Technical: (ARL, AMSAA, ARDEC)

Programmatic: (Sensors & Lasers, Soldier Weapons, Maneuver Ammunition Systems)

Warfighter Panels

Over 200 officers and NCOs

>50% of military panel members were infantry MOSs

Military panel members averaged ~15 months OEF/OIF experience

Small Arms CBA

What Soldiers Need

- **See the enemy**
  - Beyond weapon ranges for situational awareness
  - At weapons ranges for engagement
  - All conditions
  - Day or night
  - Bad guys vs. civilians

- **Kill the enemy**
  - Really about effect (or incapacitation)
  - Impacts of range versus time
  - Noise and light discipline
  - Breaching capability
  - Maintenance and Reliability

Not exactly a revelation

A different approach in small Arms

Soldier + Training + Weapon + Optic + Ammo = Effect

Soldier Lethality

Lethality isn't just about the weapon…..

- **Soldier**
- **Training**
- **Weapon**
- **Optic**
- **Ammunition**

EFFECT

Improving Soldier Lethality

- **Lethality is like real-estate……location, location, location**
- **Solutions to improve lethality**
  - 0-50m: Training, Ammo and Techniques
  - 50-500m: Training and Optics/Fire Control
- **Factors for hitting downrange targets**

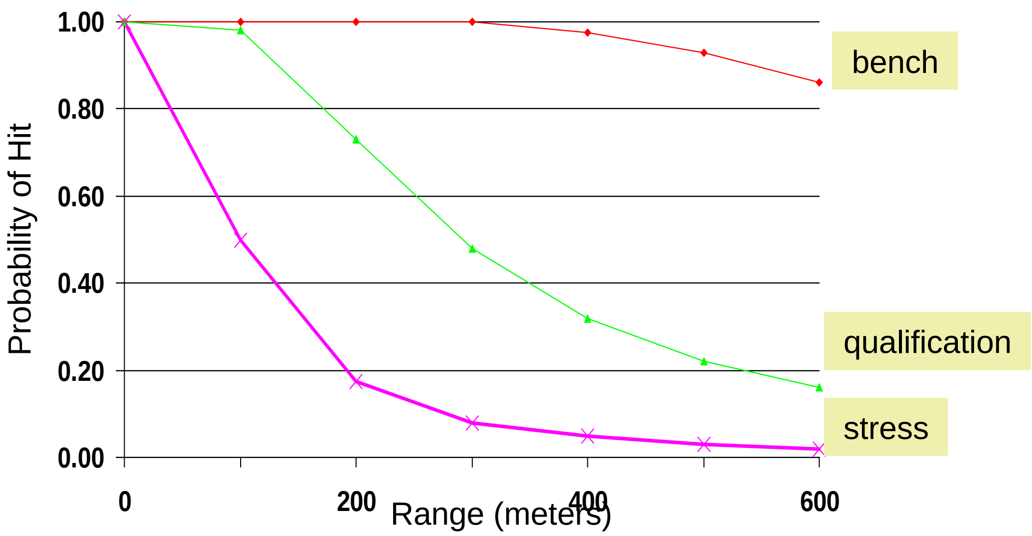
Requires quality hit <u>on</u> the target

#1 Aim point

#2 Range Estimation

#3 Environmental

#4 Dispersion of weapon



Today’s Small Arms Capability

- M4 is effective weapon in combat
- Expanded issue of Rail Adapter System
- Unprecedented capability (optics+)

- Enormous field support for all 3 weapons
- Expanded issue of optics on M249 & M240B
- Improved of night capability
- Effective sustainment of M249

- Currently fielding M110 Semi-Auto capability
- Expanded use of precision engagement assets
- Fielding of Advanced Sniper Accessory Kit

Tomorrow's Small Arms Capability

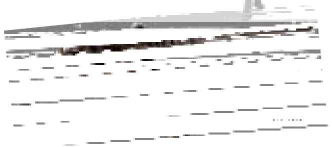
Modular Handgun System

Subcompact

Expand Carbine Issue

- Monitor Air Force handgun effort
- Add sub-compact capability to the force
- Optics on every weapon
- Expand precision engagement capability in squads





M240E6

E50

Lightweight 50

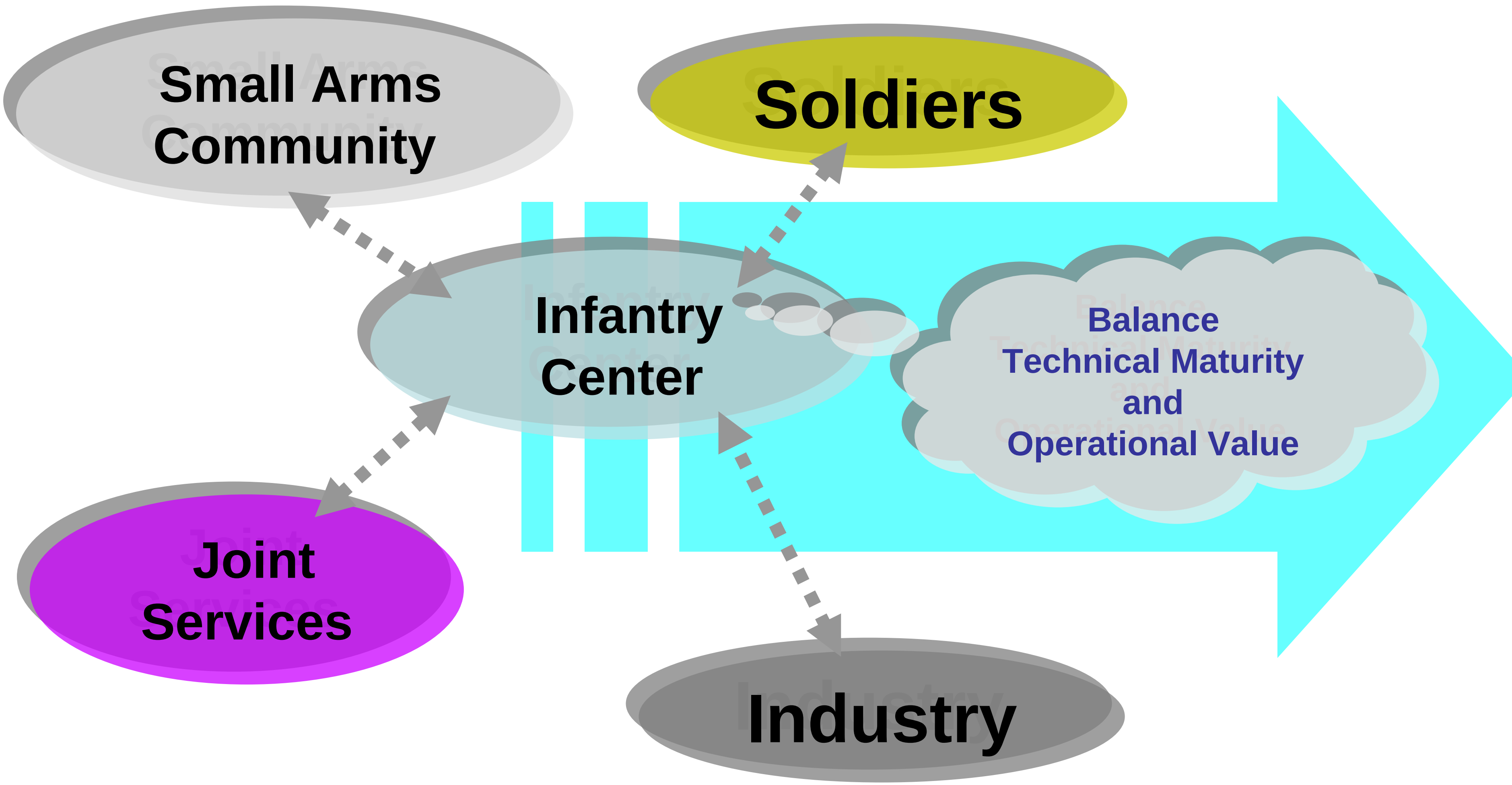
- Performance, Safety, Reliability, Weight
- M240E6 4.5 lb lighter, lighter tripod
- Heavy Machinegun day optic
- E50, Fixed Head-space and timing, quick change barrel



1500m capability

- Expand capability of sniper suite, issue
- Pursue 1500m anti-personnel weapon

Strategic Communications



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Summary

Enable Soldiers to be effective in their operational environment

Interoperability and Integration of Dismounted Soldier System Weapon Systems Update

Mr. Mark Richter
Chairman
SCI-178 RTG-043

21 May 2008

Program Manager

Marine Expeditionary Rifle Squad

Marine Corps Systems Command

Quantico, Virginia

Overview

- NATO Research and Technology Organization: formed in 1998; ensures the Alliance has at its disposal the best scientific knowledge and technical capability that member nations are prepared to make commonly available. R&T must be responsive to changing requirements and conditions, long term capability requirements, and new science and technology advancements. See www.rta.nato.int for more info.
- Land Capability Group-1 Weapons and Sensor Sub Group desired to initiate a R&D effort to answer critical weapons subsystem problems for current interoperability issues and long term soldier system interfaces and development issues.
- 10 Countries from LCG-1 teamed together: Canada, Germany, Italy, The Netherlands, Norway, Romania, Slovakia, Spain, Sweden, and United States (Army and Marine Corps). Submitted a proposal to the NATO RTO Panel which was approved.
- Exploratory Team developed Terms of Reference, Technical Activity Plan, and Plan of Work during 2005. A Task Group was initiated in January 2006 with a completion timeline slated for December 2008.
- Membership in the Task Group requires countries to allocate resources to support the Task Group.
- Task Group meets every 3-4 months.
- Includes live fire events with current and prototype soldier system equipment.

Objectives

- Recommendation for NATO standard Weapons System Interface STANAG.
- Define and Outline Human Systems Integration principles and concepts for future Soldier Weapons Systems.
- Investigate the Power Requirements for future weapon systems and methods of providing or generating power.

Organization

- The Task Group is led by the Chairman and the Heads of Delegation of the 10 countries.
- Three sub groups
  - Technical Interface Team: Led by Mr. Per Arvidsson from Sweden.
  - Human Factors Team: Led by Major Linda Bossi from Canada.
  - Power Team: Led by Mr. Karl Heinz Rippert from Germany.
- All three Teams have to work together because of overlap in various areas.
- Completion of tasks: NLT December 2008
- One year extension requested for increase scope of work. Pending approval by RTO HQ’s.

Requirements for future rail

- Straightness
- Repeatability
- Zero retention
- Power supply
- Data transfer
- Physical characteristics
- Environmental resistance

- Per Arvidsson will cover this in more detail in his presentation following this one.

Digital Models

1	M203 Grenade Launcher	
2	Bayonet	
3	C79 Scope	
4	Tactical Flashlight	
5	Holographic Sight	
6	Laser Sight	
7	Tri Rail Mount	

8	AN/PVS-13 Thermal Weapon Sight	
9	AN/PVS-14 I2 Sight	
10	Off-bore Camera	
11	Controls (e.g. Radio)	
12	FCU-HW Fire control for M203	
13	Battery Stock	
14	Butt-stock Magazine Pouch	

Preliminary Model

- Example digital models of rifle and ancillary equipment.

Equipment
1. M203 Grenade Launcher
2. Bayonet
3. Telescopic Scope (Elcan C79)
4. Tactical Flashlight
5. Holographic Sight
6. Laser Sight (e.g. red dot)
7. Tri Rail Mount
8. Off-bore camera
9. Controls (e.g. radio controls)
10. Battery Stock
11. Butt-stock magazine pouch
12. Thermal weapon sights (AN-PVS-13 Medium, Small)
13. I2 (Image Intensification) sight (AN-PVS-14)
14. Fire control unit for M203

Configuration	Equipment	Total Mass
Light	C7A2 only (loaded)	3.53 kg
Medium	C7A2 plus 1,2,3,4	6.45 kg
Heavy	C7A2 plus 1,2,4,7,8,10,11,12, 14	9.68 kg

Light Weight Rifle

Light (3.78 kg): C7 assault rifle, holographic sight, and 1 loaded (30 round) magazine

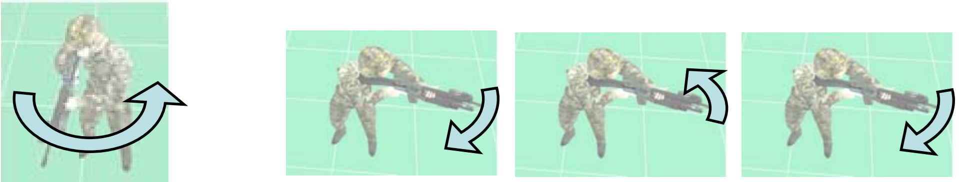
Medium Weight Rifle

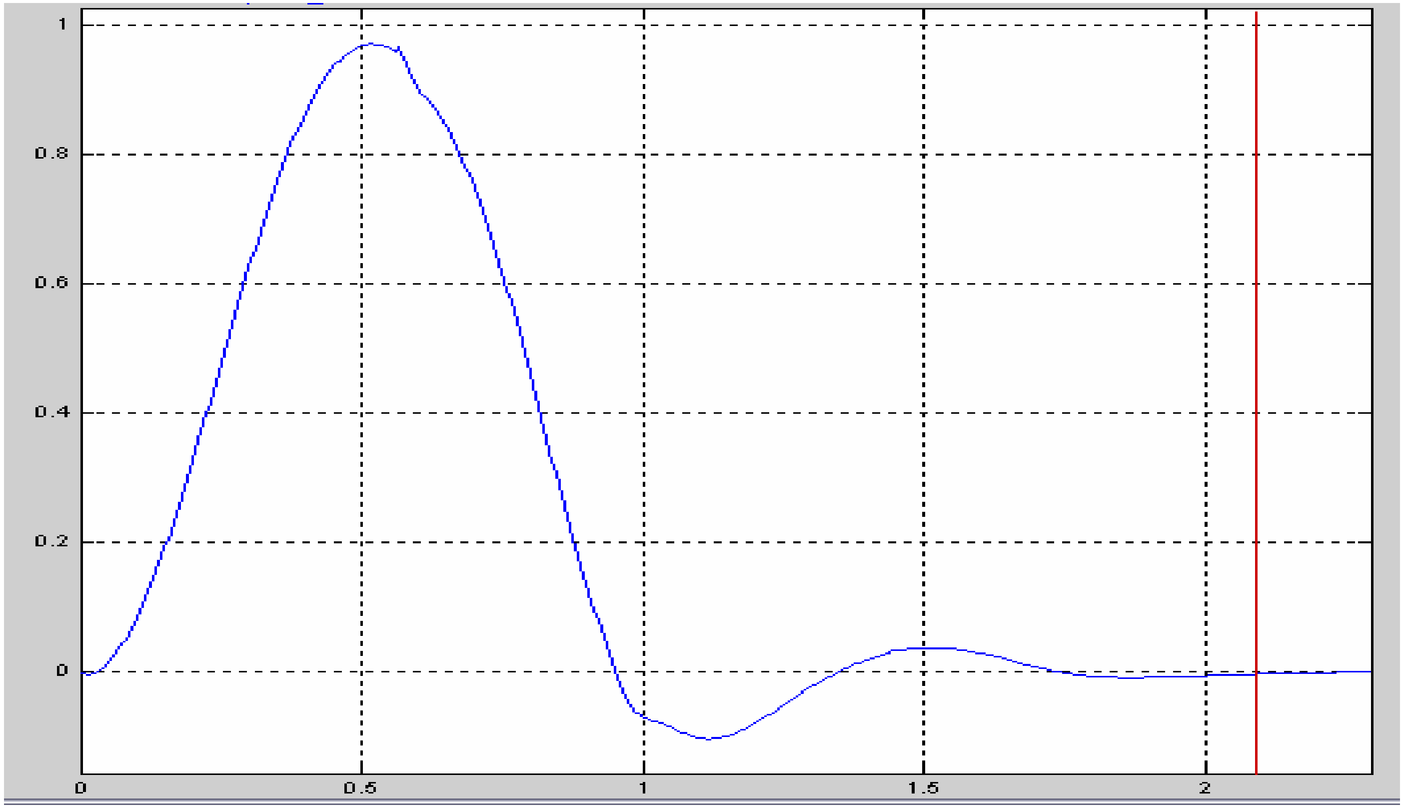
Medium (6.14 kg): C7 assault rifle, 1 loaded (30 round) magazine, ELCAN C79 Optical Sight, M203 Grenade Launcher, Flashlight, and Laser Aimer

Heavy Weight Rifle

Heavy (8.31 kg): C7 assault rifle, 1 loaded (30 round) magazine, M203 Grenade Launcher, AN/PAS Thermal Weapon Sight, tactical flashlight, and bayonet

Angular Velocity

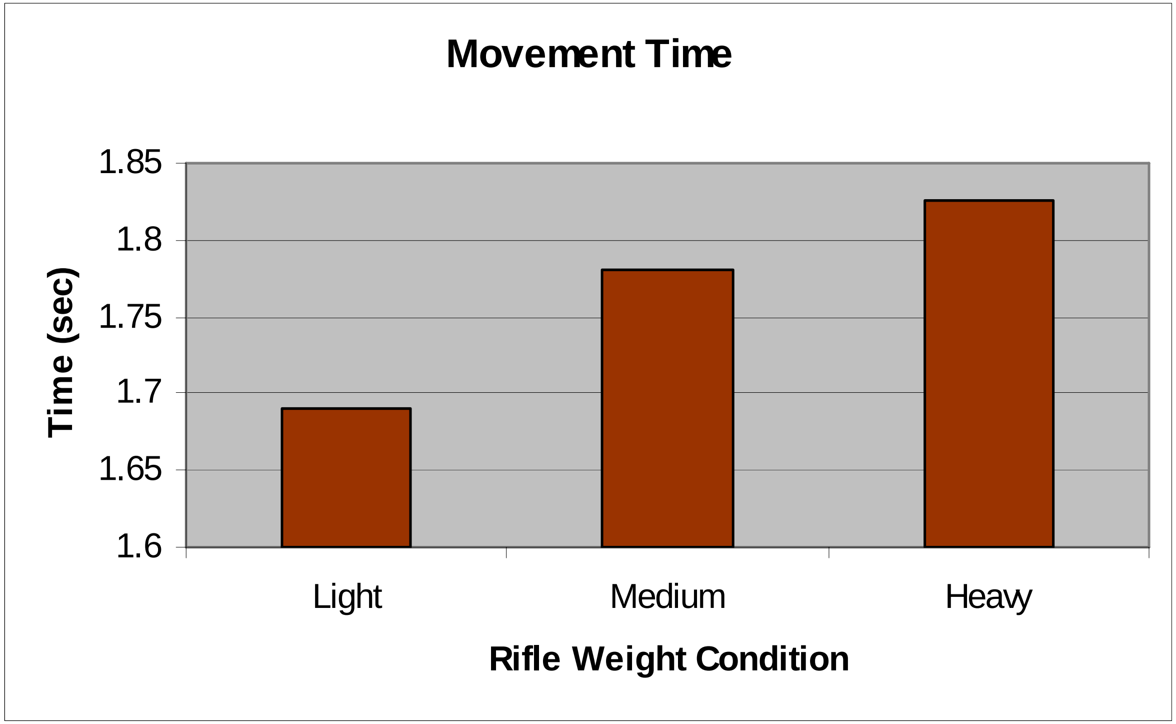




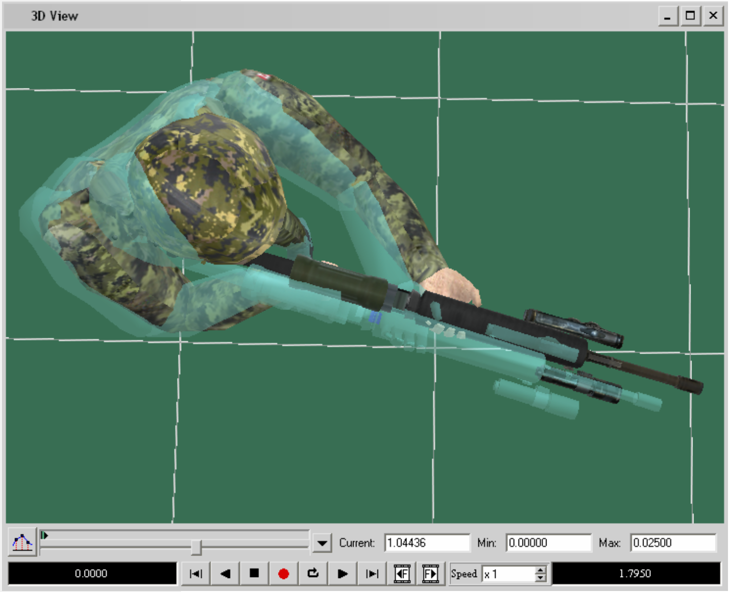
Angular Velocity (radians/sec)

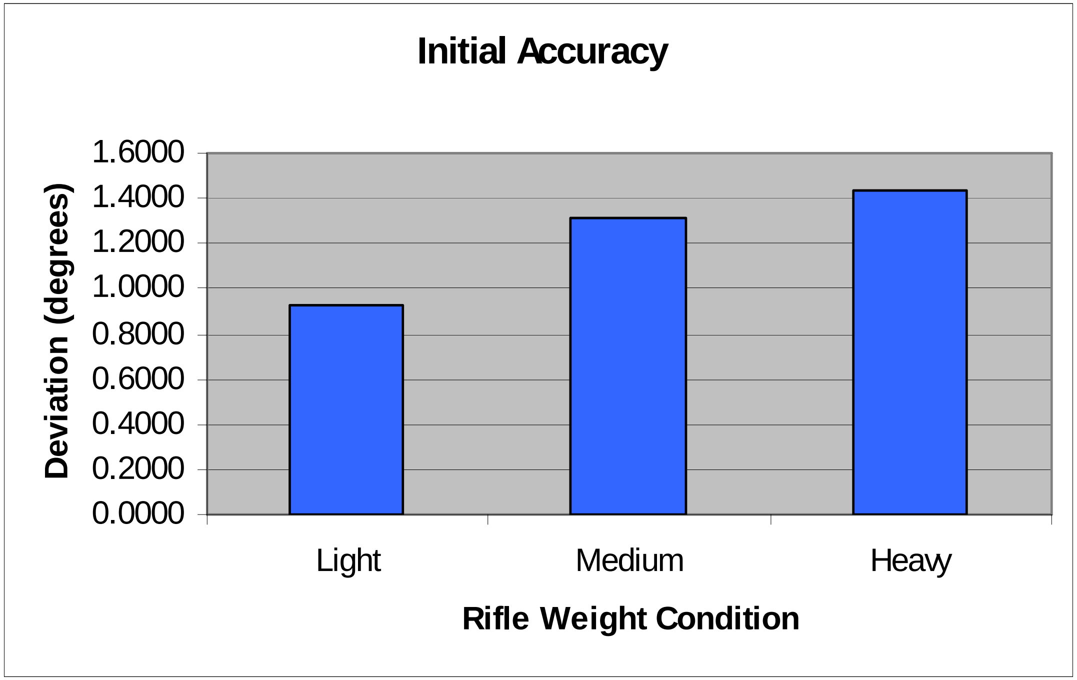
Time (sec)

Movement Time



Movement Accuracy





Weapon Sighting

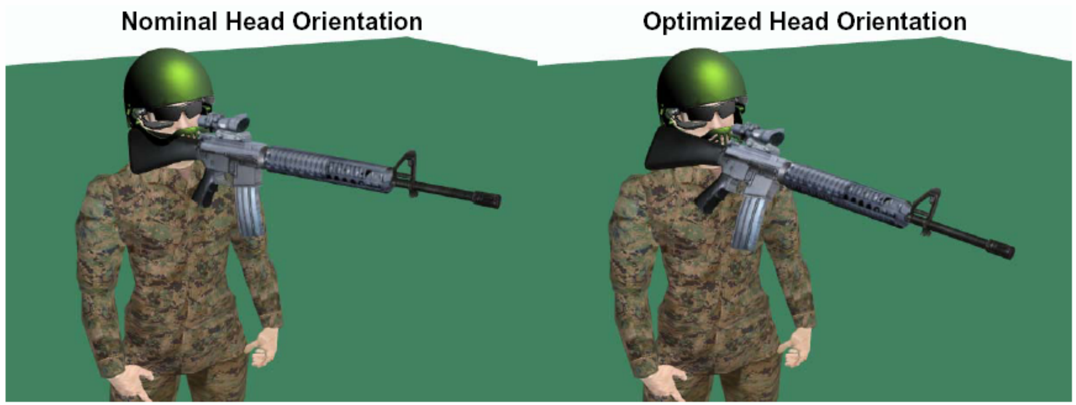
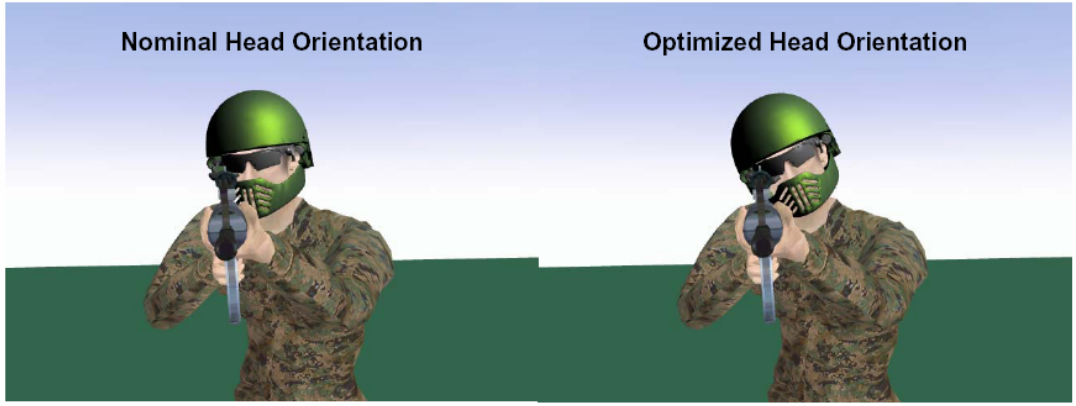


Figure 2-4 Formulating Desired Orientation Euler Angles

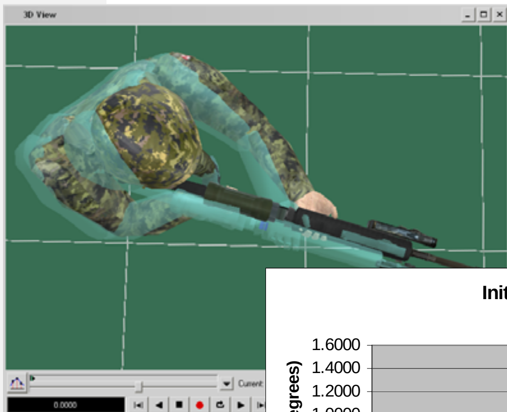


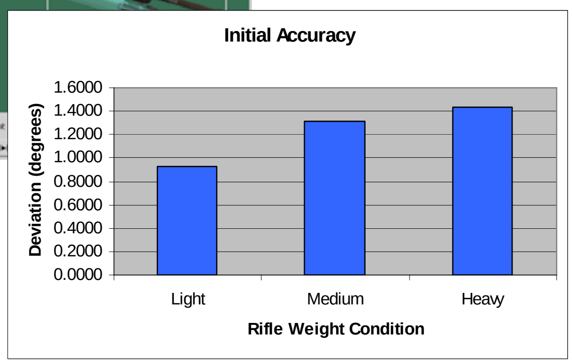
Future Soldier Systems

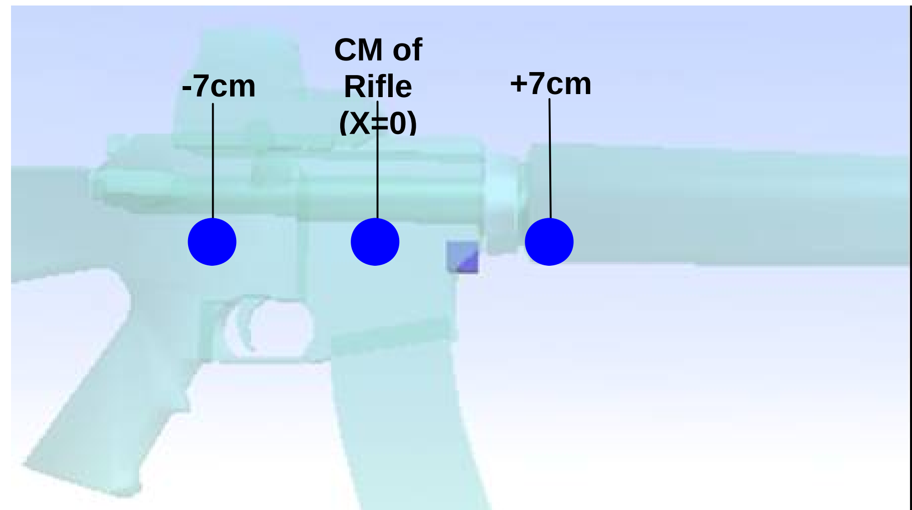
Testing Evolutions

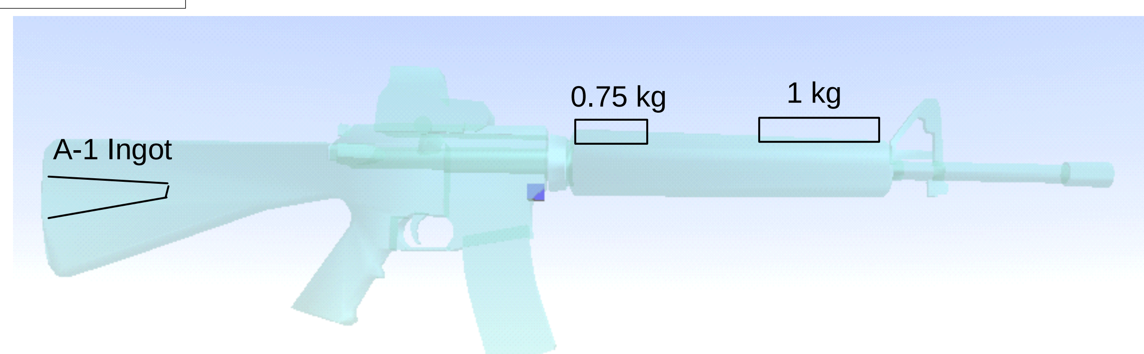
- Rifle Weight Study
  - Range Firing
    - Engagement Performance
    - High Speed Camera Data
  - Extended Hold
  - Obstacle Course Traverse
- Sight Offset Study
- Butt Stock Integration Study

Rifle Weight & CoM



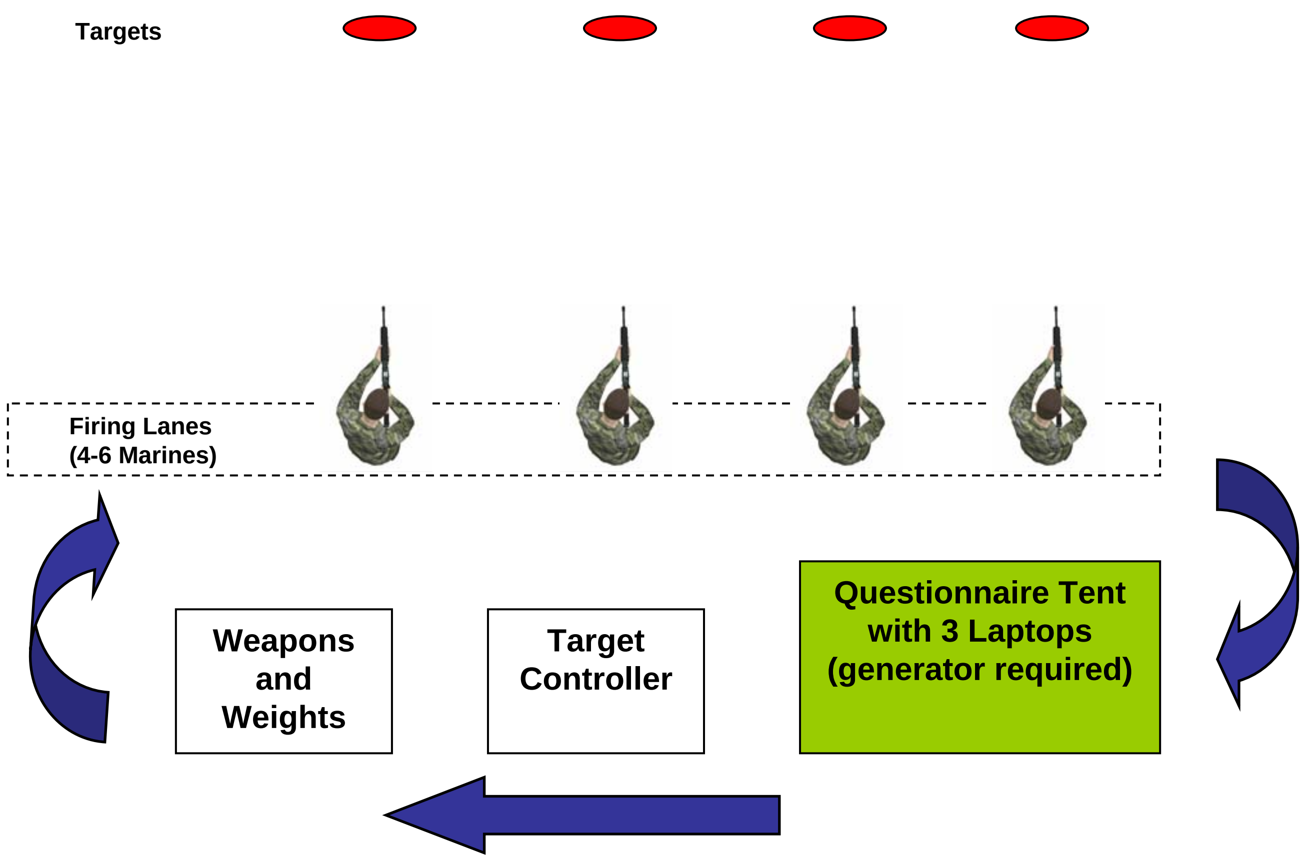






Rifle Weight System

Range Setup and Flow

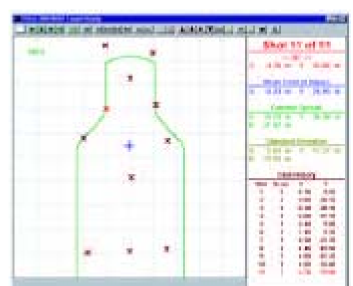


Range Serials

- Pivot and Fire
  - 90º from right and left (controlled pairs)
  - 180º from right and left (controlled pairs)
- Mozambique “failure to stop” Drill
  - 90º pivot from right and left
  - Hammer pair chest and single shot to head
- Extended Hold and Fire
  - 20 second hold on aim point
  - 5 rds aimed shot grouping

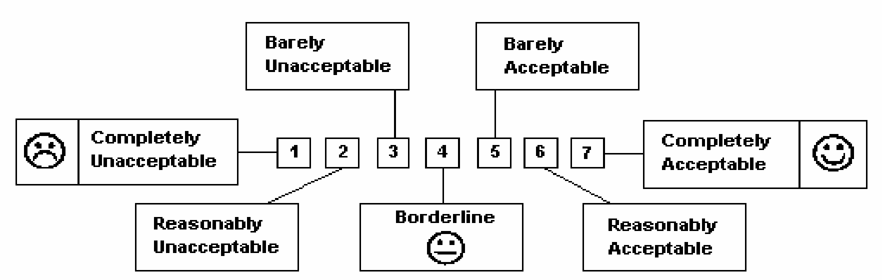
Automatic Target Scoring

- Accuracy of shot
- Shot grouping
- Time to Engage



Subjective Measures

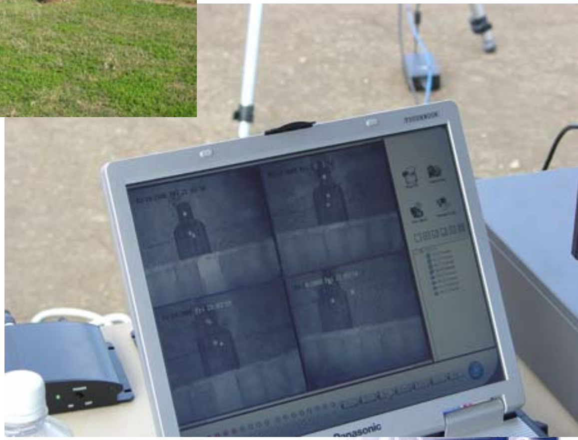
- Shooting
- Handling
- Obstacle Traverse
- Computer Kiosk



Video Recordings

- Muzzle Rise
- Slew
- Rifle Control





Extended Hold

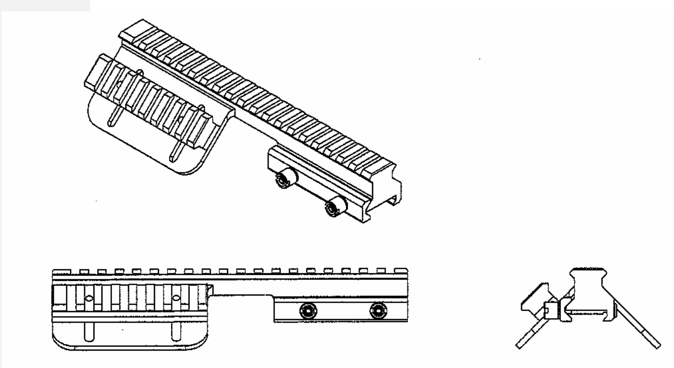
- 50 sec hold on target point.
- Baseline, 4 kg front, and 4 kg back.
- Video sight imagery.
- Time for hold.
- RPE.

O-course Mobility

- 15 Marine Participants
- Time to complete
- RPE
- Questionnaire Kiosk

O-course Mobility

Sight Offset Study

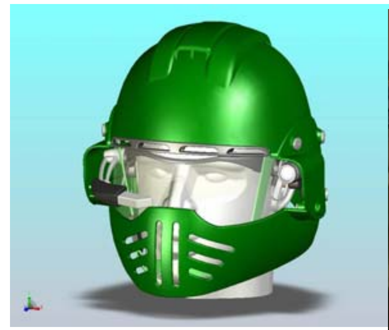


Sight Off-set Study

- Pilot study with seven Marines
- CG634 Add-on System
- In-line and lateral off-set sights.
- Time to engage and accuracy data.

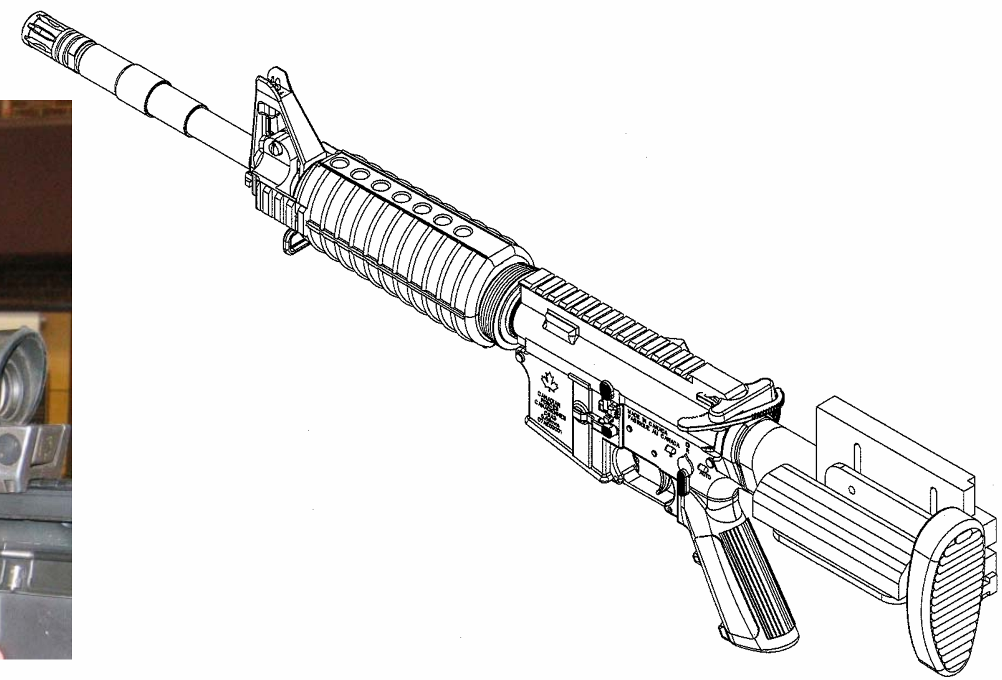
Butt Stock Integration

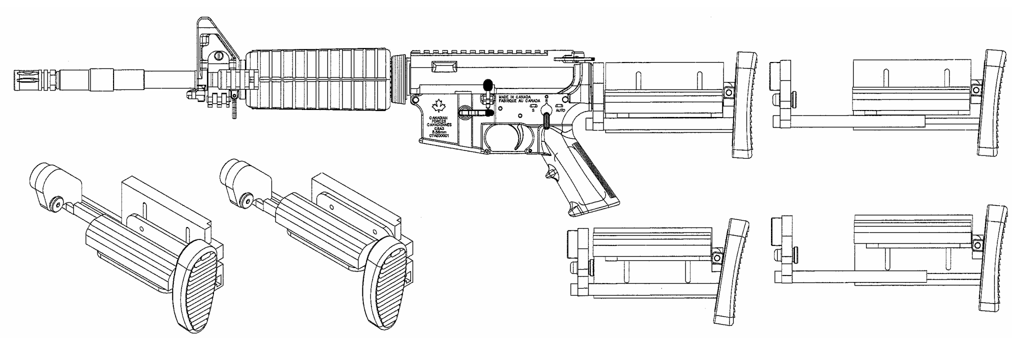
- Protection Issues
- Target Engagement Issues






Butt Stock Integration





Buttstock and HBS Integration

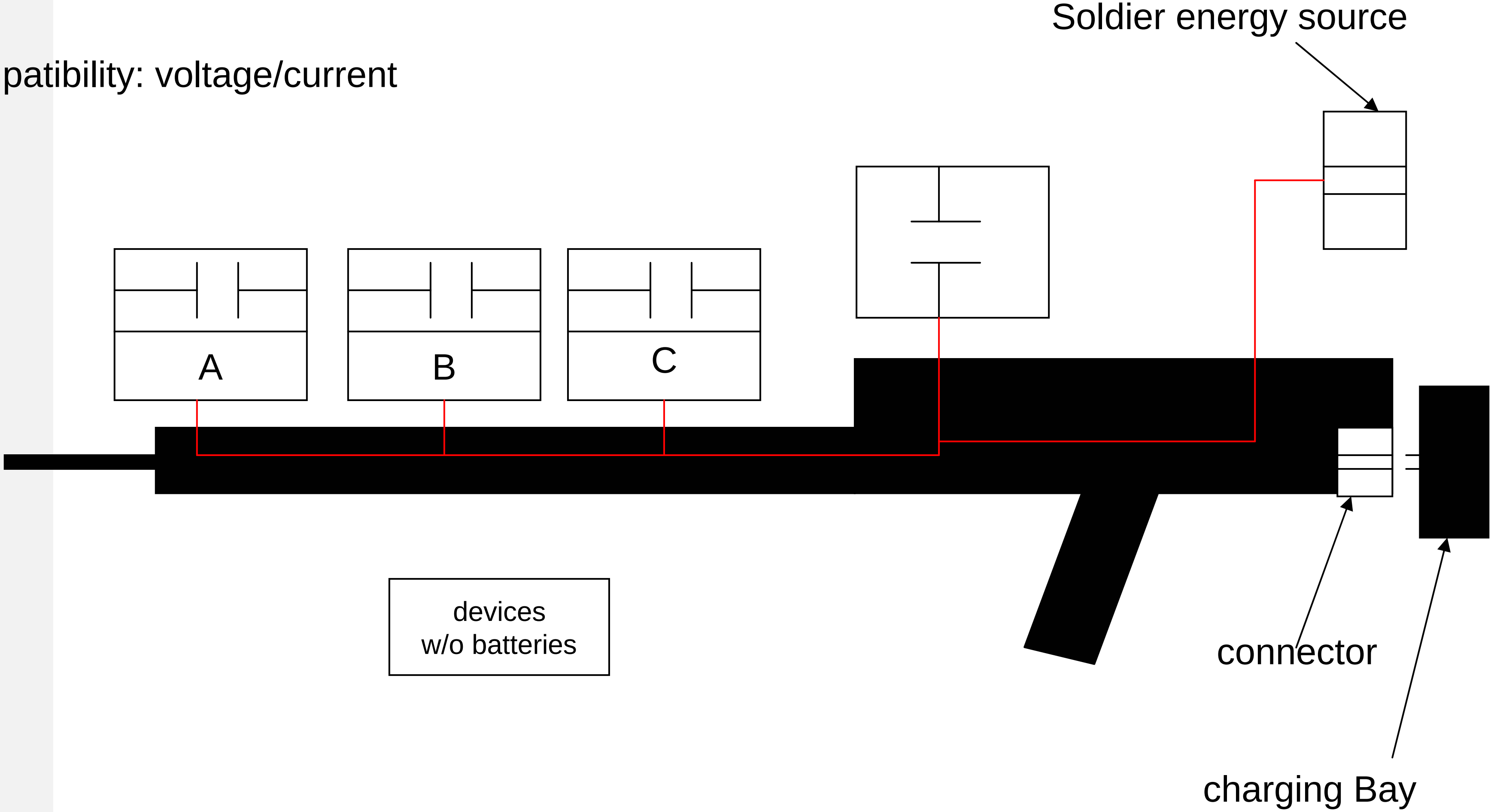
Power Issues

Interoperability and Standardization

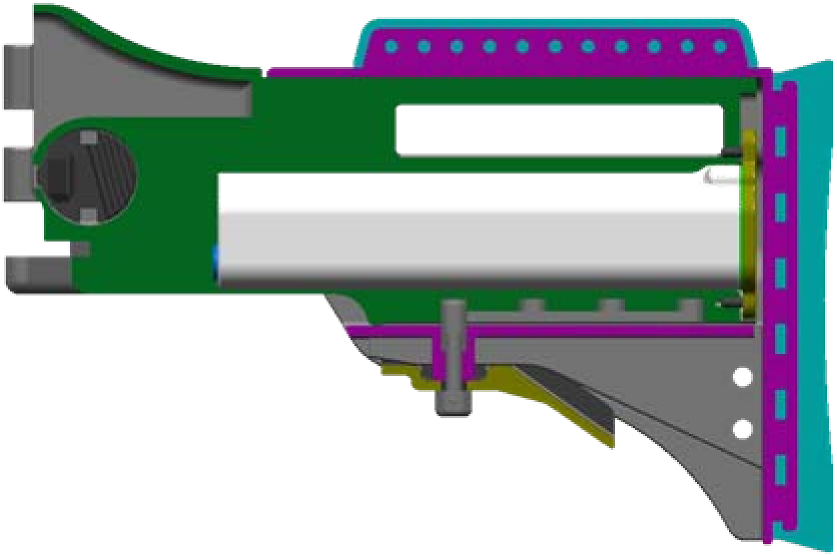
- Difficult to standardize on one battery type - “family” of batteries need to be explored (part of report)
- Consult with HF and Interface
  - “maximum” room on weapon (size, weight and location) could be recommended for future weapons concepts
- Common connection to outside – LCG1 has overarching document on C4I architecture

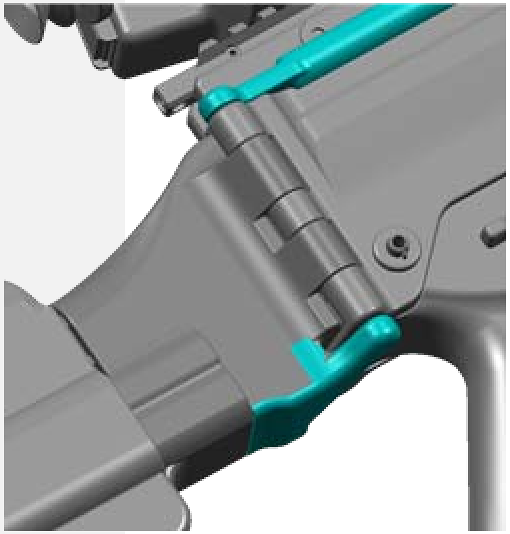
Power requirement schematic
No data connection

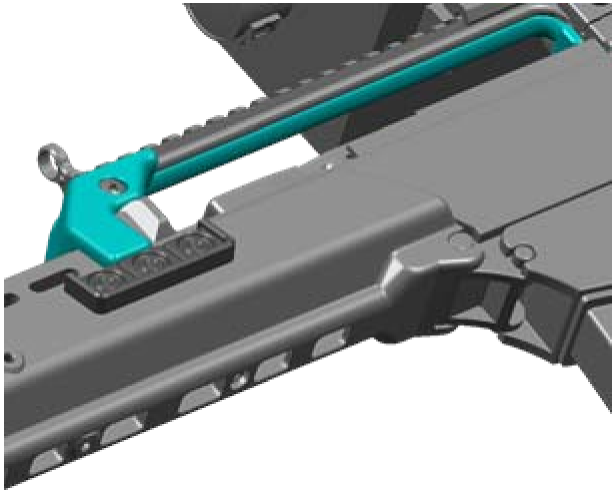
Compatibility: voltage/current



Batteries in Butt stock G36







2008 Remaining Work

- Additional Human Factors trials with Swedish soldiers in June 2008
- Live fire trials with Italian soldiers in September 2008
- National data collection by participating countries
- Finish analysis of data and complete reports.
- STANAG submission on NATO standard rail.
- Remain on schedule

2009 Scope of Work (Additional Year)

- Technical Interfaces – recommendation for a powered NATO rail annex to the delivered NATO rail STANAG.
- Human Factors – additional scope of work to include weapon information display characterization, standardization of control devices. The additional year also allows for additional data collection through more live fire trials of the weapon weight characteristics. Lessons learned from recent live fire trials and newly acquired data collection equipment has increased the scope of issues associated with integration of emerging technologies.
- Power – finalize experimentation and trials to determine the tactical benefits of power rails and implications with implementation of centralized power source. During this additional year, the technical interface sub group will merge with the power group and power will be the overall focus of effort.

Industry Participation

- Participation of Industry encouraged to assist in the success of this Task Group.
- Provide support to the sub groups areas of expertise.
- Sponsorship by a participating nation or information presentation or work.
- Intellectual Property; preference for open source
- Solicitations provided by participating countries
- On schedule to finish current tasks. Awaiting one year extension. 2009 we will combine the Interface and Power sub team into one group.

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- Germany- Mr. Karl-Heinz Rippert
- Italy- Col Carmelo de Giorgio
- The Netherlands – Major Franz van Weenan
- Norway- Mr. Haakon Fyske
- Slovakia- Mr. Lubomir Uherik
- Spain – Mr. Angel Perez
- Sweden- Mr. Per Arvidsson
- Romania – Major Tiberius Tomoiaga
- United States Army – Mr. David Ahmad
- United States Marine Corps – Mr. Mark Richter

Time for a Change

U.S. Military Small Arms Ammunition
Failures and Solutions

NDIA Dallas, TX
21 May 2008

Gary K. Roberts, LCDR, USNR

Author's Background & Qualifications

Dr. Roberts is currently on staff at Stanford University Medical Center; this is a large teaching hospital and Level I Trauma center were he performs hospital dentistry and surgery. After completing his residency at Navy Hospital Oakland in 1989 while on active military duty, he studied at the Army Wound Ballistic Research Laboratory at the Letterman Army Institute of Research and became one of the first members of the International Wound Ballistic Association. Since then, he has been tasked with performing military, law enforcement, and privately funded independent wound ballistic testing and analysis. He remains a Navy Reserve officer and has recently served on the Joint Service Wound Ballistic IPT, as well as being a consultant to the Joint FBI-USMC munitions testing program and the TSWG MURG program. He is frequently asked to provide wound ballistic technical assistance to numerous U.S. and allied SOF units and organizations. In addition, he is a technical advisor to the Association of Firearms and Toolmark Examiners, as well as to a variety of Federal, State, and municipal law enforcement agencies. He has been a sworn Reserve Police Officer in the San Francisco Bay Area, where he now he serves in an LE training role.

1. Training…and More Training

2. Reliable and Durable Weapon System

3. Ammunition Terminal Performance

The first two items must be fully and adequately addressed before the third item becomes a serious concern…

What's Wrong With This Picture?

In 1940, the prototype P51 Mustang successfully flew just 178 days after the initial order had been placed. Now in the 21st century, despite the efforts of many smart folks, few small arms improvements seem to get rapidly completed and expediently fielded--there is a significant gap between what we KNOW and what we actually DO for our warriors. If such glacial procurement had occurred during WWII, the war would have ended before any new weapons were fielded.

SALVO, SPIW, 6 mm SAW, ACR, XM29, XM8…even with modern engineering, CAD/CAM techniques, and new materials many proposed U.S. small arms and ammunition improvements cost tens of millions of dollars, years of RDT&E, and then rarely seem to ever actually reach the field.

Millions of dollars are poured into next generation small arms technologies with no near-term potential to improve combat capability, like caseless, telescoping, snd air-burst ammo, while simple innovative incremental advances that can immediately make an impact in combat operations, like barrier blind ammunition and intermediate calibers, get minimal funding or are ignored.

DOD replaces computer hardware and software every 3 or 4 years, yet does not offer the same type of incremental improvements for small arms weapons and ammunition, despite similar costs.

The sacred alter of "green" ammo has sucked up tens of millions of dollars over many years in the nebulous pursuit of "non-toxic" ammunition, yet with a few COTS exceptions, has not resulted in any improvements in ammunition reliability, accuracy, or terminal performance--the factors that actually help win fights.

Overly complex, fundamentally flawed computer modeling and excessive statistical manipulations that don't reflect reality are often used to try and predict military ammunition terminal performance and "lethality" instead of the more common sense approach using the physiological damage based methodology proven to closely correlate with numerous actual shooting incidents in over two decades use by law enforcement agencies and wound ballistic researchers.

The United States made several major missteps in its search for the ideal combat rifle caliber. In the late 1920's, the U.S. Army selected the .276 Pederson caliber produced by Frankford Arsenal as the best caliber for a new semi-automatic rifle. The .276 fired a 125 gr bullet at approximately 2700 f/s. Ordnance trials determined that John Garand's new .276 caliber T3E2 rifle was an ideal combat weapon, however, development of the .276 rifle was halted in 1932 because of the large remaining stocks of old .30-06 caliber M1906 150 gr FMJ ammunition left over from WWI; thus the U.S. military threw away an opportunity to adopt the superior performing .276 caliber and the M1 Garand rifle was adopted in the old .30-06 caliber.

Following WWII the United States Army again made a colossal weapon system selection error when it rejected the British .270 caliber 130 gr and .280 caliber 140 gr ammunition fired at approximately 2400 f/s and instead insisted on the full power 7.62 x 51 mm cartridge that offered nearly identical ballistic characteristics as the old .30-06 it replaced. Given the 7.62 mm's extremely short life as the standard service rifle caliber, in hindsight, we can hypothesize that both the .270 (6.8 mm) and .280 (7 mm) would probably have been ideal combat rifle calibers and might still be in use today if either had been chosen.

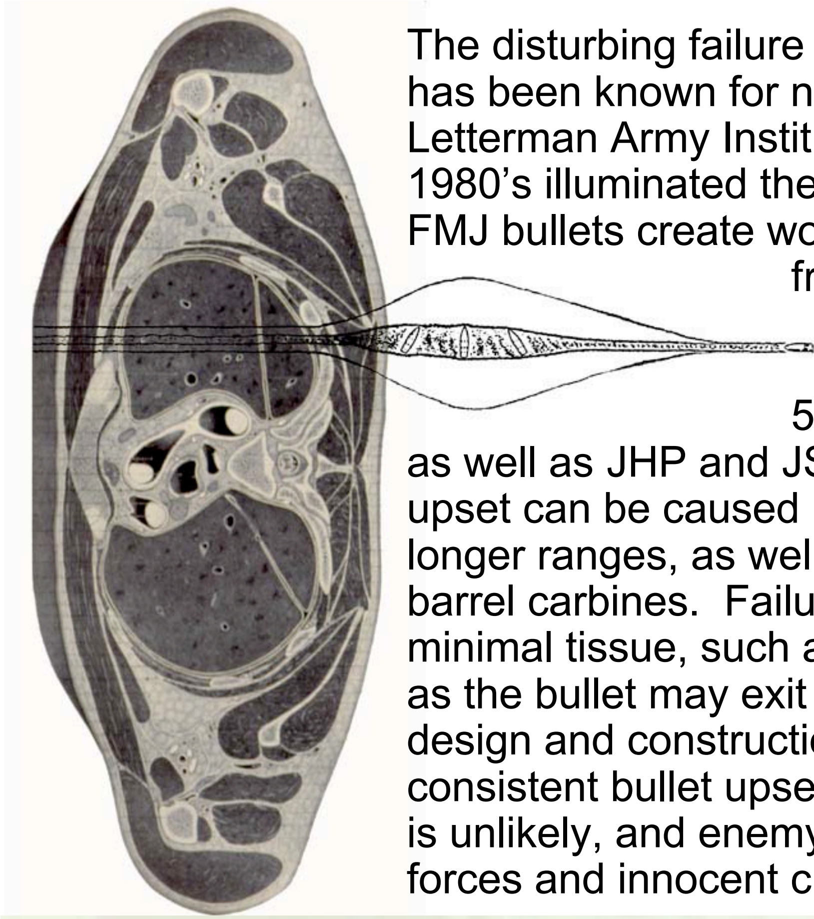
In 1972, the U.S. Army issued a MNS and detailed specifications for a new SAW/LMG. At that time, in reviewing calibers for the new system, 5.56 x 45 mm was felt to lack effective range and terminal performance while 7.62 x 51 mm was felt to be too heavy; weapon developers and joint users felt no current weapons systems and calibers could meet the requirements, thus a new compromise caliber was necessary--this became the 6 x 45 mm SAW. The 6 mm SAW used a 105 gr low drag bullet fired at around 2450 fps. In 1976, the Army ordered that SAW design efforts be redirected, this included stopping development of the 6 mm SAW cartridge (in part for fear of irritating our NATO allies) and focusing efforts on 5.56 mm LMG designs (XM248/(XM235), XM249/(FN Minimi), XM262/(HK21A-1).

While 5.56 mm 55 gr M193 (FN SS92) was standard in the 1960's and 1970's, attempts to improve 5.56 mm effectiveness included the XM287 68 gr FMJ and the IWK 77 gr FMJ--both used in the Stoner 63 by NSW in Viet Nam; the 54 gr XM777, as well as the SS109 62 gr FMJ developed by FN for their Minimi LMG. As we all know, the end result was the 1980 decision to adopt the 5.56 mm Minimi as the M249 SAW and the SS109 as the 62 gr FMJ M855 "green-tip".

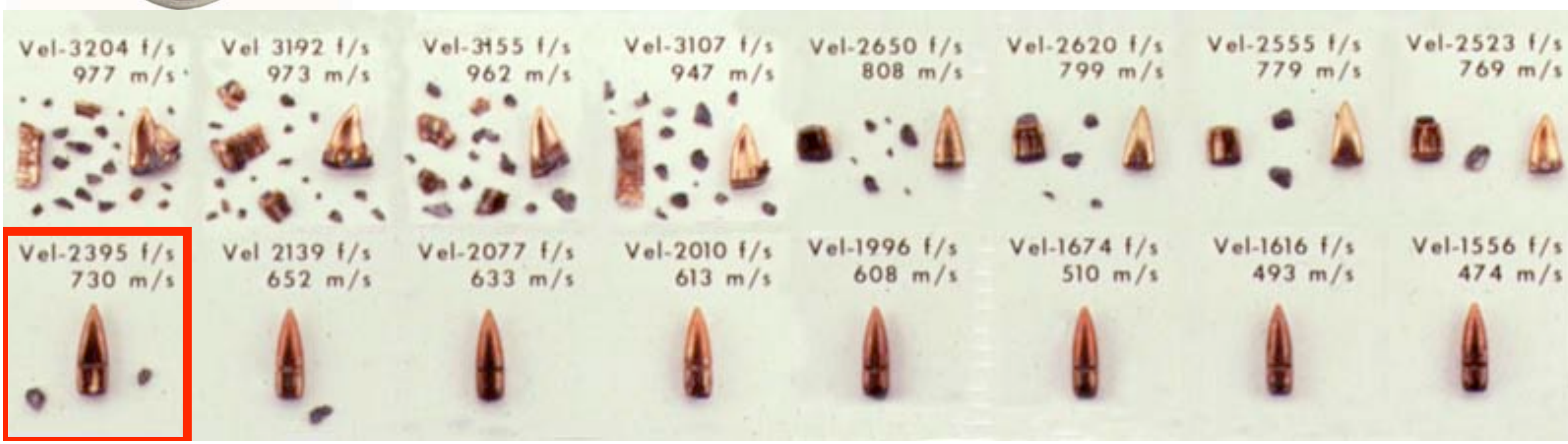
As noted, 5.56 mm NATO 62 gr SS-109/M855 FMJ was designed over 30 years ago as linked machine gun ammunition to be fired from the FN Minimi/M249 SAW while engaging enemy troops wearing light body armor during conventional infantry combat at distances of several hundred meters--while not a perfect solution, M855 does perform adequately in this role.

Unfortunately, combat operations since late 2001 have again highlighted terminal performance problems, generally manifested as failures to rapidly incapacitate opponents, during combat engagements when M855 62 gr "Green Tip" FMJ is fired from 5.56 mm rifles and carbines. This is not surprising, since M855 was not originally intended for use in carbines or rifles, especially those with short barrels. In addition, most 5.56 mm bullets are generally less effective when intermediate barriers, such as walls, glass, and vehicles shield opponents--this is a significant consideration in urban combat. The decreased incapacitation potential of 5.56 mm compared with larger rifle calibers is intrinsic to the small caliber varmint hunting roots of the 5.56 mm cartridge; in many states it is illegal to hunt deer size game with 5.56 mm, so why do we expect it to offer ideal terminal performance against aggressive, violent 100-200 lbs human opponents?

As an interim solution to these problems, deployed SOF units have used 5.56 mm Mk262. The Black Hills produced Mk262 uses the 77 gr Sierra Match King (SMK) OTM and is built as premium quality ammunition intended for precise long-range semi-auto rifle shots from the Mk12 rifle. It is great for its intended purpose. Mk262 has demonstrated improved accuracy, greater effective range, and more consistent performance at all distances compared to M855 when fired from current M16, Mk12, M4, HK416, and Mk18 rifles and carbines. However, despite this substantially improved performance, Mk262 still manifests the problems of poor intermediate barrier penetration and somewhat variable terminal performance inherent with the SMK design.

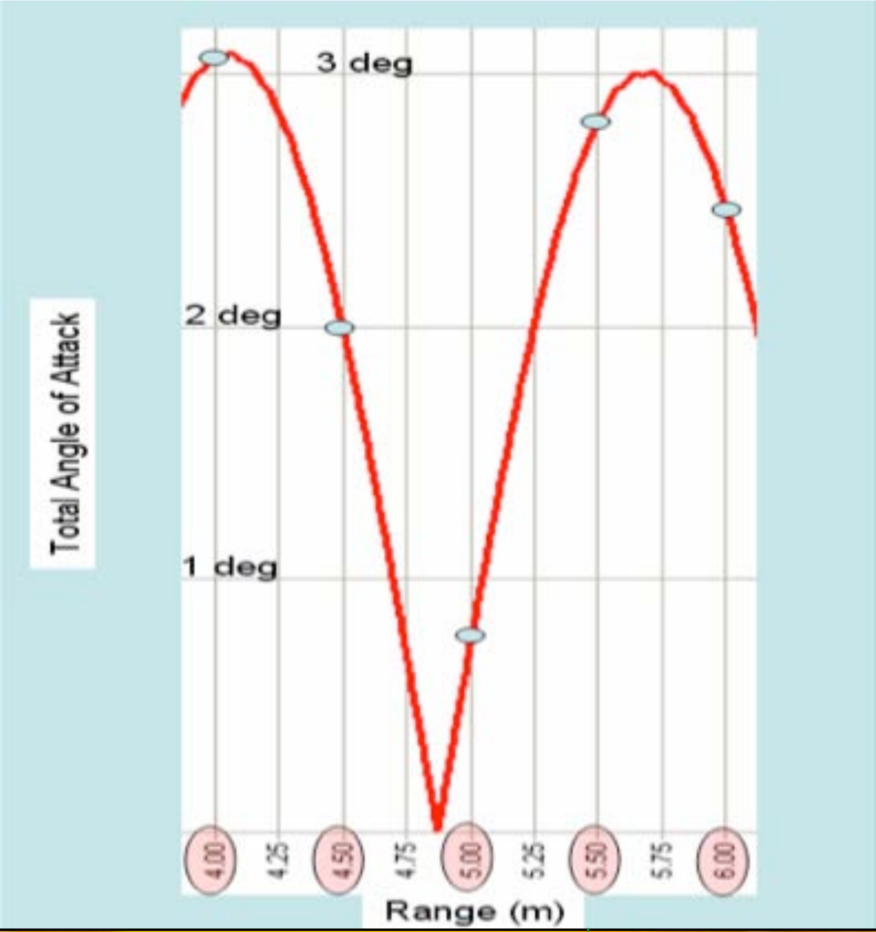


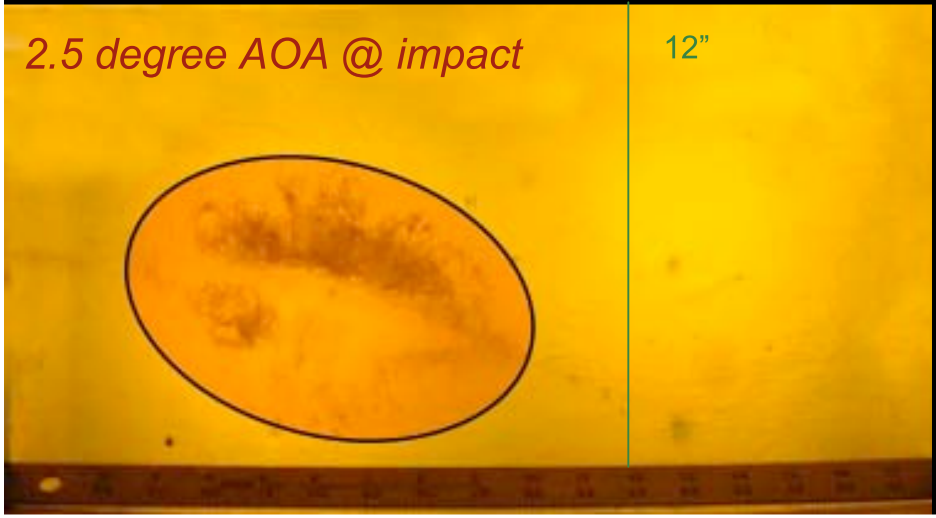
The disturbing failure of 5.56 mm to consistently offer adequate incapacitation has been known for nearly 15 years. Dr. Fackler's seminal work at the Letterman Army Institute of Research Wound Ballistic Laboratory during the 1980's illuminated the yaw and fragmentation mechanism by which 5.56 mm FMJ bullets create wounds in tissue. If 5.56 mm bullets fail to upset (yaw, fragment, or deform) within tissue, the results are relatively insignificant wounds, similar to those produced by .22 LR--this is true for ALL 5.56 mm bullets, including military FMJ , OTM, and AP, as well as JHP and JSP designs used in LE. This failure of 5.56 mm bullets to upset can be caused by reduced impact velocities when hitting targets at longer ranges, as well as by the decreased muzzle velocity when using short barrel carbines. Failure to upset can also occur when bullets pass through minimal tissue, such as a limb or the torso of a thin, small statured individual, as the bullet may exit the body before it has a chance to upset. Finally, bullet design and construction plays a major role in reliable bullet upset. Without consistent bullet upset, wounding effects are decreased, rapid incapacitation is unlikely, and enemy combatants may continue to pose a threat to friendly forces and innocent civilians.

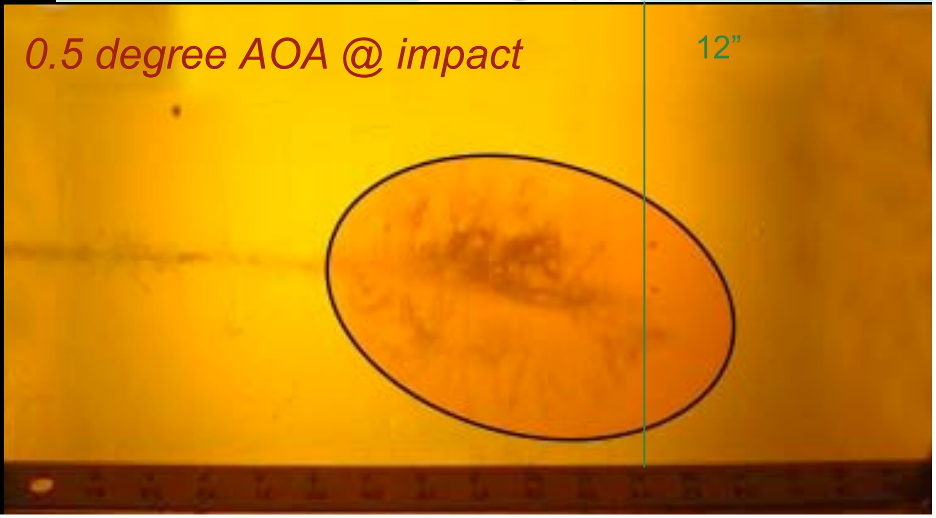


Angle-of-Attack (AOA) variations between different projectiles, even within the same lot of ammo, as well as Fleet Yaw variations between different rifles, were recently elucidated by the JSWB-IPT. These yaw issues were most noticeable at close ranges and were more prevalent with certain calibers and bullet styles—the most susceptible being 5.56 mm FMJ ammunition like M855 and M193.

What this means is that two shooters firing the same lot of M855 from their M4's with identical shot placement can have dramatically different terminal performance results: one shooter states that his M855 is working great and is effective at dropping bad guys, while the other complains his opponents are not being incapacitated because M855 is zipping right through the targets without upsetting. Both shooters are telling the truth…







As articulated by combat AAR's the last few years and demonstrated in recent military wound ballistic testing, improved combat ammunition that is specifically designed for rifle and carbine use, not machine guns, is urgently needed. New loads should offer:

- JAG approval
- Full reliability in diverse environmental extremes
- A thermally stable propellant
- Consistent lot-to-lot and shot-to-shot performance, even when fired from short barrel weapons
- Crimped and sealed primer
- Sealed case mouth
- Cannelure for functional reliability in adverse conditions
- Decreased muzzle flash
- Acceptable accuracy at 300-500m
- Good soft tissue terminal performance (early consistent bullet upset within 1 or 2 inches of initial tissue penetration
- 12-18 inches of penetration coupled with maximized tissue damage during the first 10 to 12 inches of travel in tissue
- Designed to minimize AOA and fleet yaw issues
- Blind to Barriers

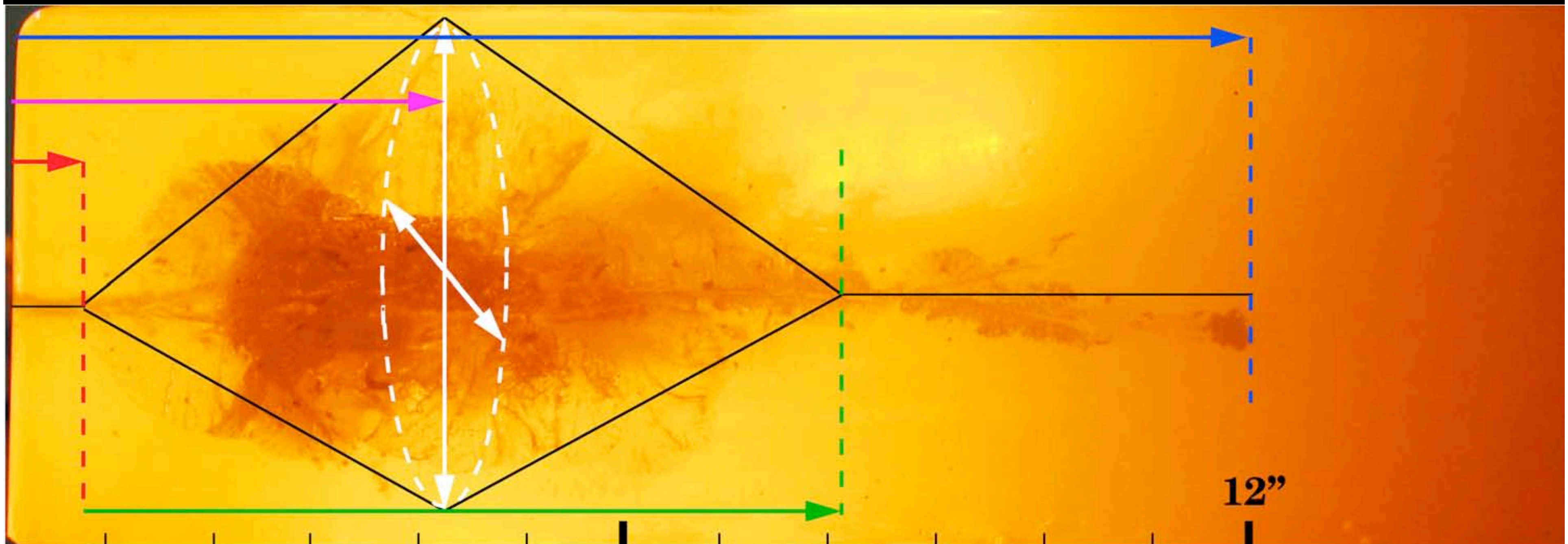
It is critical that new combat ammunition be "Blind to Barriers" and not suffer from terminal performance degradation from intermediate barriers--especially automobile windshields & doors, and common structural walls.

Ammunition should be light and compact enough for the operator to carry an adequate supply in magazines of at least a 25 round capacity. The rifle should be similar in size, weight, and ergonomics to the proven M4/M16 weapons. Recoil should be manageable to allow full auto fire when necessary, along with the more usual rapid, aimed semi-automatic fire.

Important Gel Block Measurements to Assess Terminal Effectiveness

The shot into bare gelatin depicted below illustrates ideal terminal performance.

"Barrier Blind" ammunition should demonstrate minimal changes in terminal performance between unobstructed shots into bare gelatin and those obstructed by intermediate barriers.



Pen = 12.1" NL = 0.8" TC = 4.5" max diam @ 4.2" depth TC length from 0.8" to 8.1" of pen

1. Initial Upset Depth (Neck Length) -- *Optimally 1" or less, up to 3"*
2. Temp Cavity Length -- *As long as possible in the first 12" of penetration*
3. Temp Cavity Height & Width -- *Bigger is better in first 12" of penetration*
4. Depth to Max Temp Cavity Diameter -- *Typically at 4" to 6" of pen*
5. Total Depth of Penetration -- *Less than 12" & more than 18" is not ideal*

Note: The ideal shot depicted above is a 6.8 mm Hornady 115 gr OTM impacting at 2600 fps

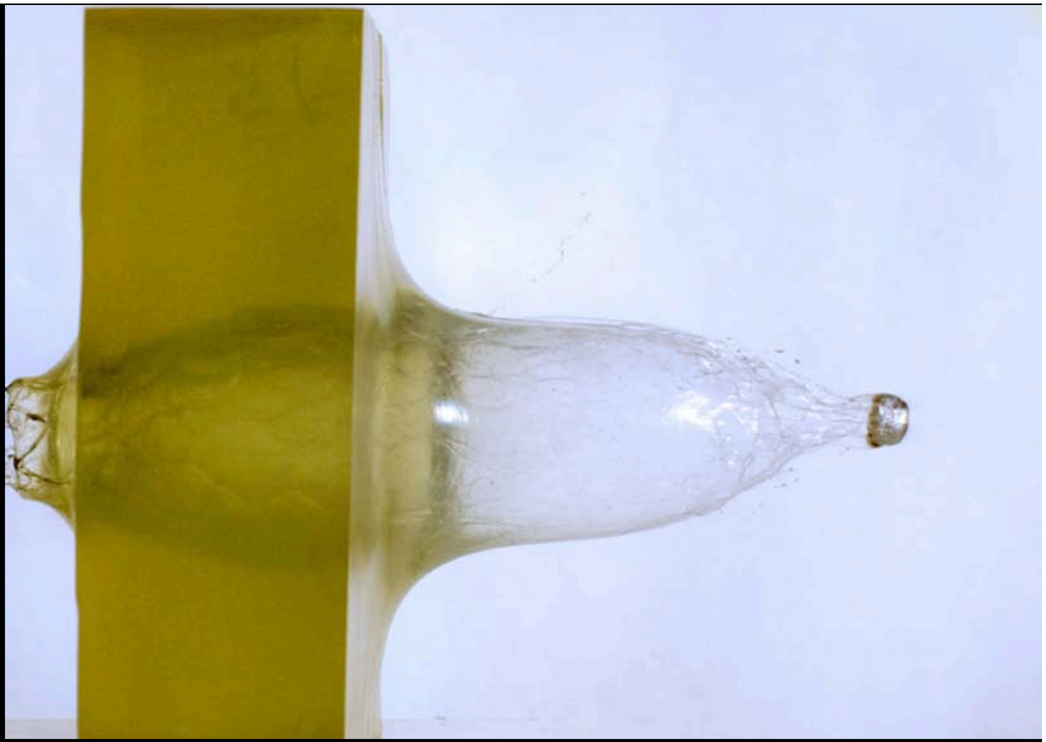
Tom Burczynski's superb photos of 5.56 mm projectiles as they penetrate through 2" wide sections of 10% gelatin clearly illustrate the critical importance of early projectile upset within the first 1 or 2" of penetration.

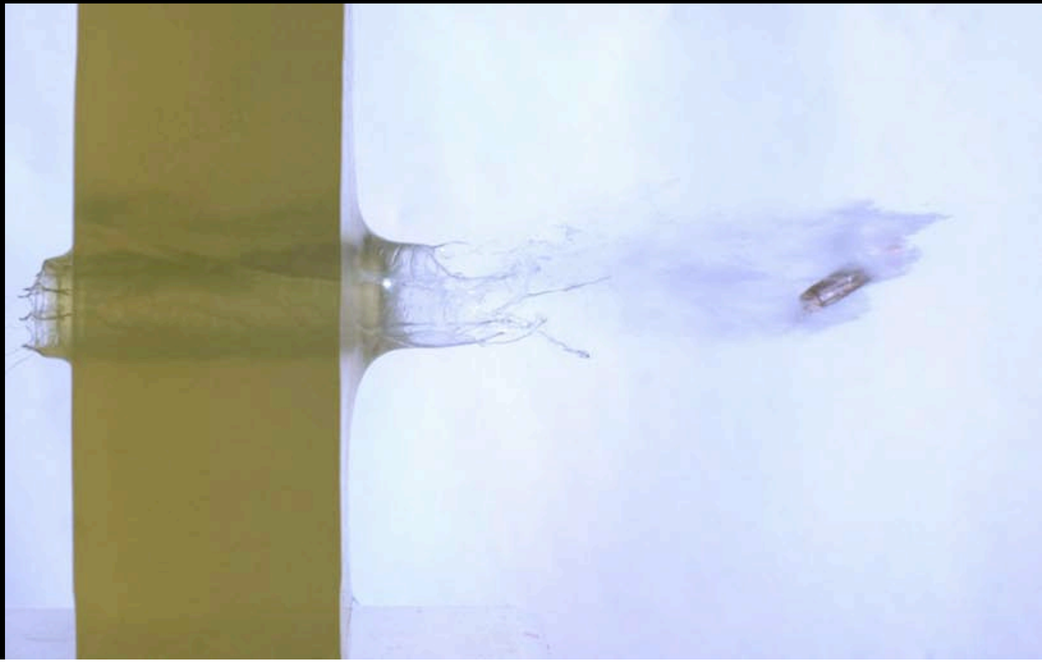
The barrier blind, FBI issued, ATK/Federal 62 gr bonded Tactical load on top has completely upset within the first 2" of gel penetration, demonstrating good tissue crush and stretch.

In contrast, the Mk262 loading using the 77 gr SMK OTM on the bottom has not even begun to upset during the first 2" of penetration through gel, resulting in minimal tissue stretch and crush at this point.

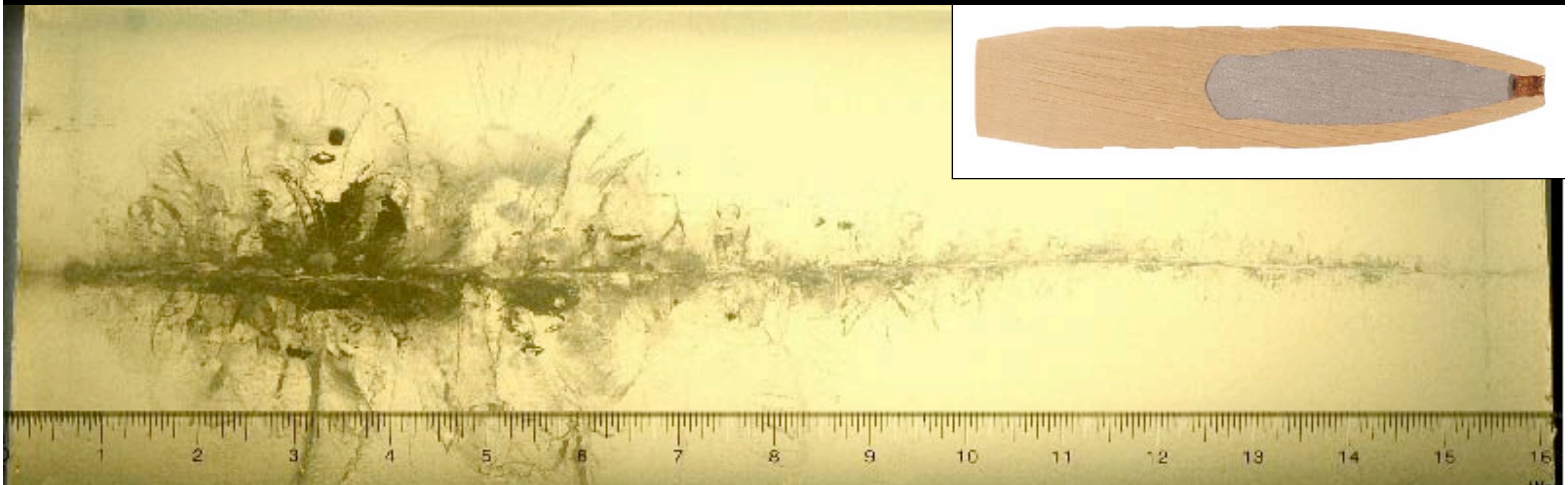
5.56 mm BOTTOM LINE

Simply adopting new 5.56 mm barrier blind combat loads that are optimized for shorter barrels, offer consistent early upset, along with adequate penetration, and minimal AOA/Fleet yaw issues may be the critical answer to many deficiencies noted with currently issued U.S. military 5.56 mm ammunition.

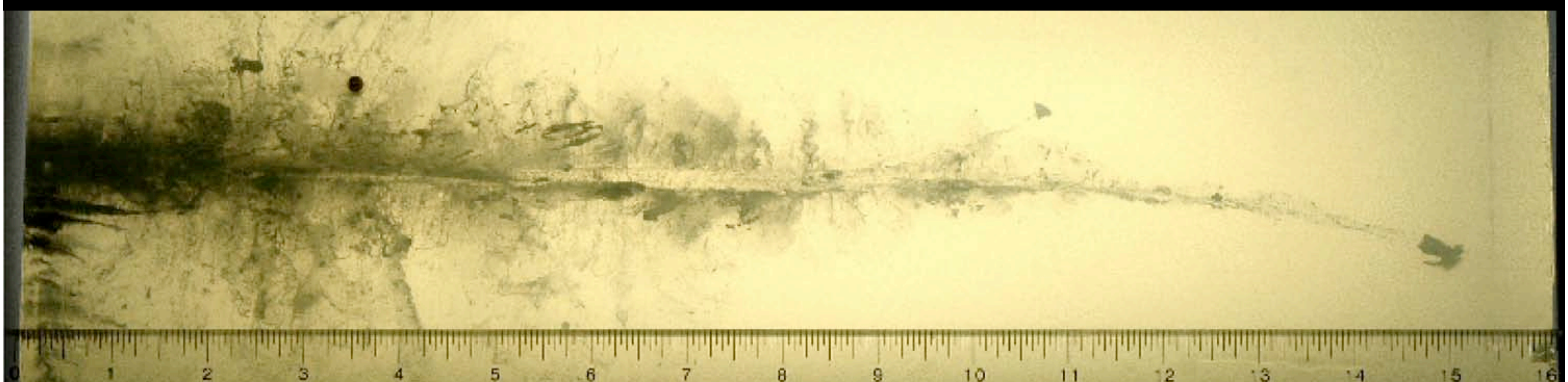




The 01 June 2006 Marine Corps RFI for “Barrier Blind” ammo yielded several good options from industry including the ATK 77 gr bonded TOTM:



Fed 77 gr TOTM in bare gel: vel = 2677 f/s, NL = 0.5”, pen = 16.75”, Max TC = 4.5” @ 4.5”, RW = 76.0 gr



Fed 77 gr TOTM auto glass: vel = 2677 f/s, NL = 0”, pen = 15.25”, Max TC = 4.2” @ 3.5”, RW = 42.8 gr

"In response to inquiries from the field, the Army's Project Manager, Maneuver Ammunition Systems (PM MAS) has assembled a team of experts from many disciplines including military users, law enforcement, trauma surgeons, aero ballisticians, weapon and munitions engineers, and other scientific specialists to answer the question--Are there Commercial Off-the-Shelf 5.56mm bullets available that are better than M855 "Green Tip" against unarmored targets in Close Quarters Battle (CQB)?"

Despite what was publicly released in the heavily truncated "final" JSWB-IPT report from May 2006, as well as the information presented in Infantry Magazine that was replete with significant data omissions, anybody who has seen the actual data from the 10,000 or so test shots collected by the JSWB-IPT at 3-10m, 100m, and 300m distances or who has read the original 331 page final draft report dated 12 April 2006, knows that the clear and unequivocal best performing cartridge in the JSWB-IPT testing was 6.8 mm. In addition, several 5.56 mm loads performed better than current M855, especially from shorter barrels. This was validated by the 11 August 2006 joint USMC/FBI Phase I Ammunition Study report that once again clearly illustrated that 6.8 mm offered the best terminal performance of ALL calibers tested. The report also demonstrated that the 5.56 mm 62 gr "Barrier Blind" load used by the FBI and other LE agencies offered superior terminal performance to current military issue 5.56 mm ammunition. The JSWB-IPT wrote:

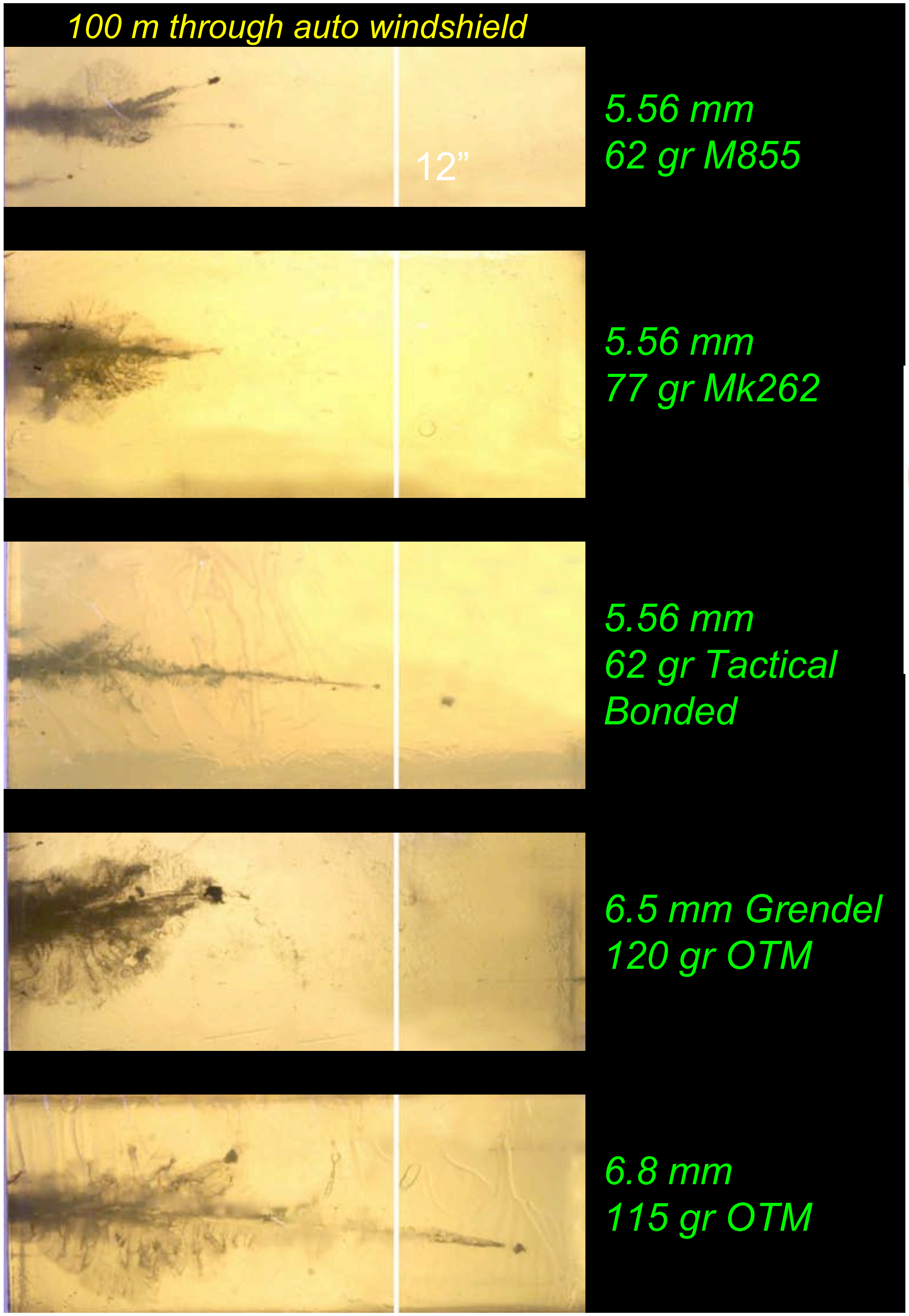
- *"The best performing systems emphasizing tissue damage, on the average, in this study were of larger caliber than 5.56 mm."*
- *"The 6.8 mm performance observed in this test suggests that an intermediate caliber is the answer to the trade-off balance issue."*
- *"The 6.8 mm projectile had a near optimal balance of MASS, VELOCITY, and CONFIGURATION to maintain its effectiveness, even at a lower impact velocity."*
- *"The 6.8mm SPC is far and above, the best performing ammunition…"*

Thus, the Road Ahead for Military Small Arms Ammunition should emphasize: "Barrier Blind" ammunition in all calibers, calibers larger than 5.56 mm, especially intermediate calibers like 6.8 mm

The SPC (Special Purpose Cartridge) program, jointly developed by 5th SFG(A) and USAMU in conjunction with USSOCOM requirement validation, built on historical data in creating the 6.8 x 43 mm SPC. 6.8 mm is the perfect refinement of the hypothesis that a 6.5 to 7 mm bullet is the ideal choice for combat; it combines the best features of both the more traditional 7.62 x 51 mm "battle rifle" cartridge and the more recent 5.56 x 45 mm "assault rifle" cartridge without either of their deficits. In addition, 6.8 mm offers superior accuracy and incapacitation potential compared to the 7.62 x 39 mm cartridge fired by AK47 rifles commonly used by our opponents. Unlike 5.56 mm NATO and 7.62 mm NATO weapons, 6.8 mm was designed from the beginning to offer optimal performance in the sub-16" short barreled carbines favored by U.S. forces fighting in urban settings and from vehicles.

6.8 mm was conceived and developed entirely by experienced military end-users based on identified combat mission needs. Their Commanders approved the project, trusted the competence of their subordinates, and supported them in developing the best solution for troops at the tip of the proverbial spear. This was a bottom-up project where the personnel who will have to use the weapon in combat for once got to develop exactly what they needed, rather than the more common top-down approach where engineers develop a product that is all too often long-delayed and that does not necessarily adequately address the needs of combat personnel in the field. The 6.8 mm SPC project was also very inexpensive—in an era of massive fiscal waste, the 6.8 mm SPC initial RDT&E costs for the government were less than $5000.

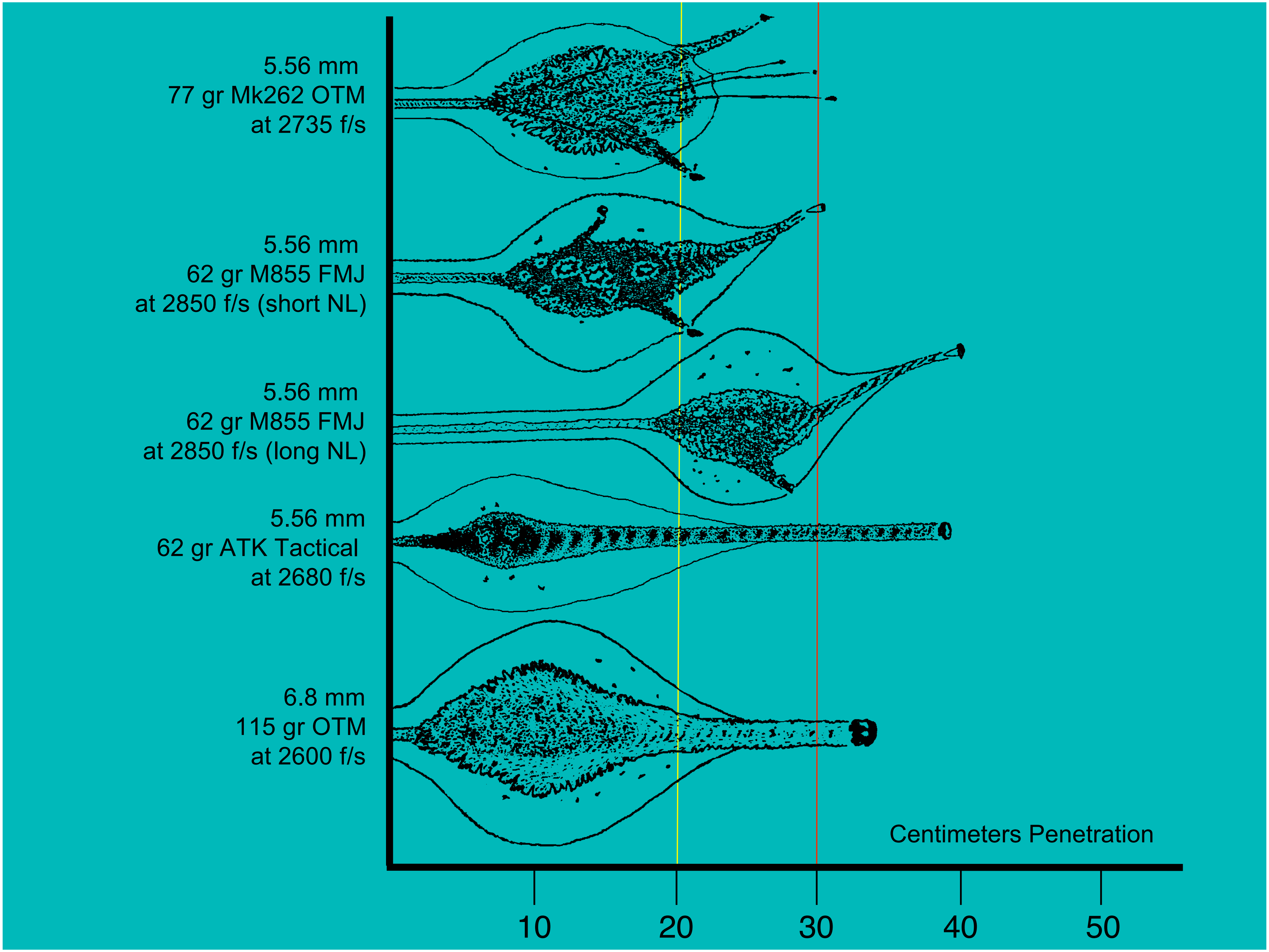
During SPC development different bullet diameters of 6 mm, 6.5 mm, 6.8mm, 7 mm, and 7.62 mm were tested, using multiple bullet types, shapes, and weights from 90 to 140 gr--the 6.8 mm was selected because it offered the BEST combination of combat accuracy, reliability, and terminal performance for 0-500 yard engagements in an M4 size package.



6.8 mm offers substantial fiscal advantages, as a significant increase in weapon effectiveness over current 5.56 mm weapons is achieved for minimal procurement costs.

The 6.8 mm can be retrofitted to any existing 5.56 mm rifle and carbine platforms, including the M4A1, Mk12 SPR, M-16, Mk18 CQB-R, HK416, FN Mk16 SCAR-L, simply by changing a few modular components, mainly barrel, bolt, and magazine.

6.8 mm magazines hold from 25-30 rounds; fortunately, 6.8 mm magazines have the same external dimensions as existing 30 round 5.56 mm M16 magazines, allowing continued use of all current load bearing equipment and magazine pouches when upgrading to 6.8 mm.

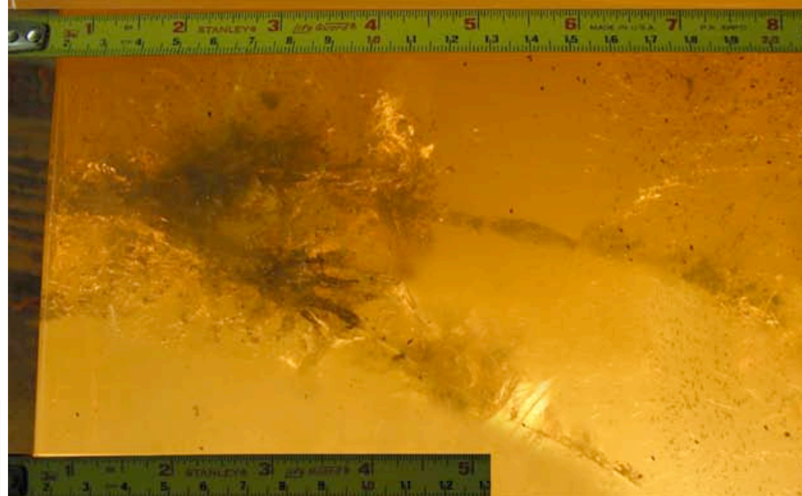

5.56 mm
77 gr Mk262 OTM
at 2735 f/s
5.56 mm
62 gr M855 FMJ
at 2850 f/s (short NL)
5.56 mm
62 gr M855 FMJ
at 2850 f/s (long NL)
5.56 mm
62 gr ATK Tactical
at 2680 f/s
6.8 mm
115 gr OTM
at 2600 f/s
Centimeters Penetration
10
20
30
40
50

6.8 mm offers superior terminal EFFECTIVENESS compared to 5.56 mm in all environments, including CQB & Urban, especially when fired from short barrels.

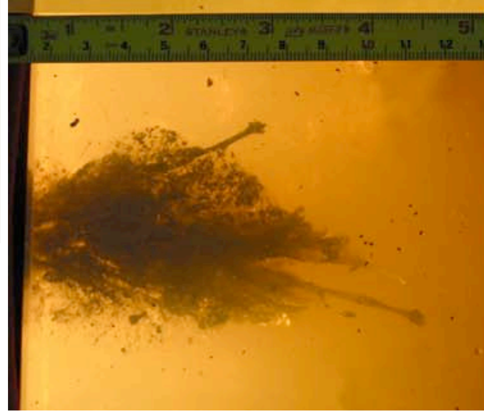
Unlike 5.56 mm, 6.8 mm continues to demonstrate good terminal performance even after defeating common intermediate barriers, such as glass, walls, and automobiles, as well as loaded AK47 magazines, like those frequently worn in chest pouches by terrorists.

Both tungsten and steel core 6.8 mm AP bullets are now available

6.8 mm 115 gr OTM fired through loaded AK47 mag at 3 meters



5.56 mm M855 62 gr FMJ fired through loaded AK 47 mag at 3 meters



5.56 mm Mk262 77 gr OTM fired through loaded AK 47 mag at 3 meters

Test Evaluation Report for the M4A1/MK12 Modified Upper Receiver Group (MURG)

Counter Terrorism Technical Support Office (CTTSO)
Technical Support Working Group (TSWG)
Tactical Operations Subgroup (TOS)

July 2007

TSWG's multi-agency clients, including DOD SMU's, Army SF, NSW, Air Force SOF, U.S. OGA's, Federal LE organizations, and select foreign military SOF units, requested an evaluation to determine if an Enhanced Rifle Caliber was currently available to meet a validated Combat Mission Needs Statement (CMNS) and Operational Needs Statement (ONS) for improving the combat performance of current rifles and carbines.

Based on all available test results to date, end-users selected 6.8 mm as the best available intermediate caliber for the TSWG multi-agency task force MURG evaluation.

Three different MURG variants were required:

-- Special Compact Carbine with 8-10" barrel (SCC = Mk18 equivalent)
-- Standard Carbine with 12-14" barrel (SC = M4 equivalent)
-- Designated Marksman-Recce with 16-18" barrel (DMR = Mk12 equivalent)

6.8 mm MURG systems from four vendors were tested: Barrett, Bushmaster, HK, LWRC, with the 5.56 mm Colt M4A1 as baseline.

Test Conclusions Include:

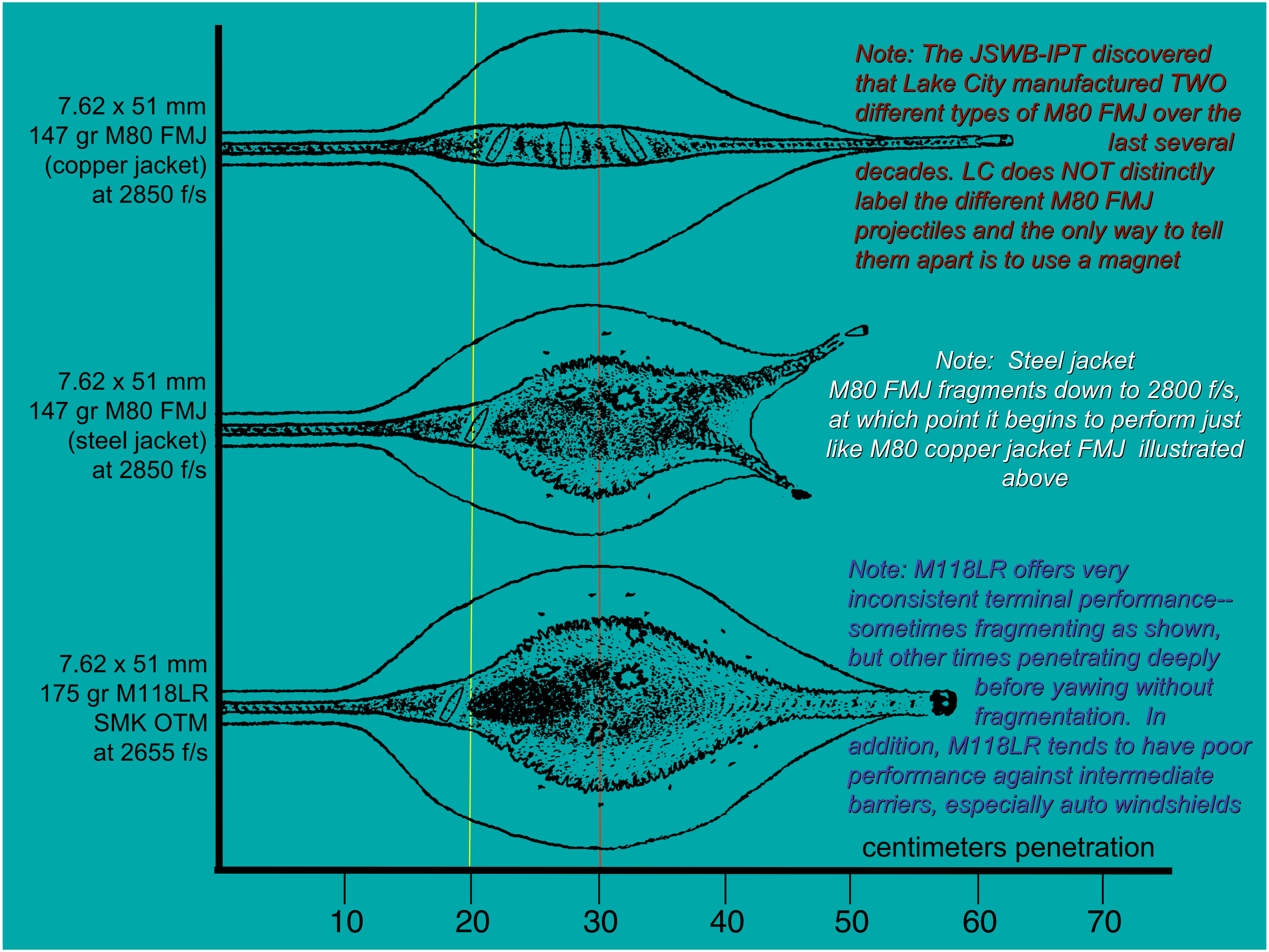
- 6.8 mm MURG is a COTS NDI item ready for full fielding in the next 12 months
- 6.8 mm MURG is fully compatible with existing M4A1 and M16 lower receivers
- 6.8 mm MURG allows end-user to change between variants in the field within seconds
- NO parts failures occurred in any 6.8 mm MURG system during testing
- 6.8 mm MURG systems exhibited accuracy, reliability, suppressor capability, recoil management, and engagement speed that were equivalent or better than current 5.56 mm weapons
- 6.8 mm MURG is available as a gas piston/op rod system for improved durability, reliability, and reduced user maintenance
- 6.8 mm MURG should be treated as an integrated system--upper, magazines, suppressor, and ammunition to ensure maximum reliability

MURG allows units to train with 5.56 mm uppers currently in service and fight with identically configured 6.8 mm uppers, as the "muscle memory", weapons handling skills, and LBE are identical.

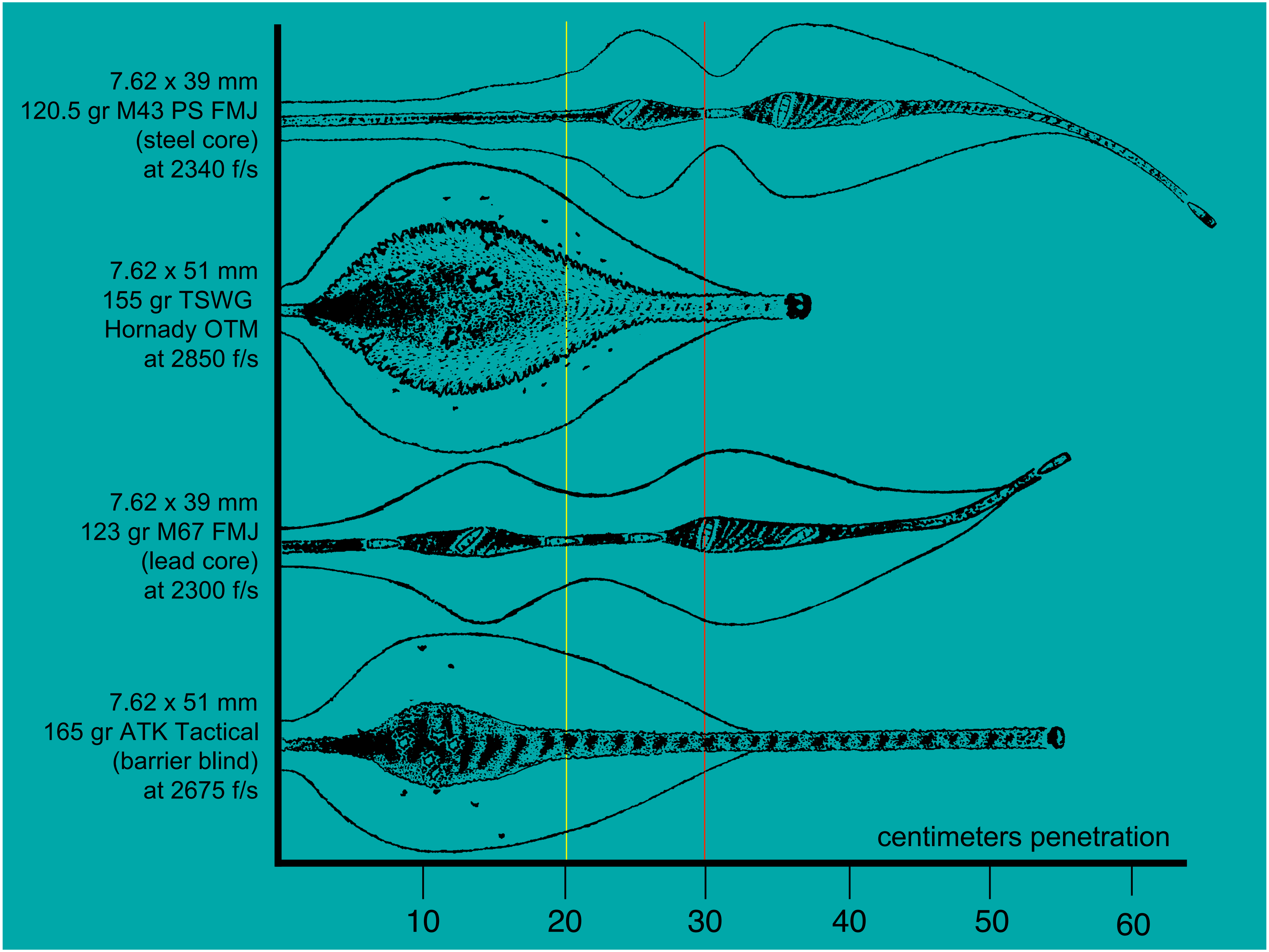
To alleviate the problems of marginal incapacitation potential and intermediate barrier penetration ability inherent with 5.56 mm, re-adoption of a 7.62 x 51 mm length cartridge is a consideration (ex. 7.62 x 51 mm, 7 x 46 mm, 6.5 mm Creedmore). The superior range, incapacitation potential, & barrier penetration ability of 7.62 x 51 mm based systems may prove a decisive advantage compared to smaller caliber weapon systems, however ammunition with terminal performance far SUPERIOR to currently issued M80 ball is MANDATORY to optimize the potential of 7.62 mm rifles for CQB and urban combat !

Neither type of current 7.62 mm M80 FMJ possesses ideal accuracy or terminal performance characteristics, especially from barrels shorter than 16-18”. 7.62 mm M118LR 175 gr OTM used in sniper rifles like the Mk11, M110, M24, and M40A3 is very accurate and offers good performance at longer ranges--making it ideal for sniper use. However, the documented inconsistent close range terminal performance and poor intermediate barrier performance of the heavy SMK OTM make it a less than ideal choice for CQB engagements, urban combat, and short barrel use. Improved ammunition is required to optimize terminal performance with shorter barrel 7.62 x 51 mm weapons (Mk14/M14 EBR, KAC SR25K, HK417, FN Mk17 SCAR-H).

Despite the many desirable characteristics of 7.62 x 51 mm based systems, they have several significant penalties, including increased cost, size, weight, and recoil, as well as decreased magazine capacity and decreased control in full auto fire. The basic ammo load is reduced and the soldier’s overall load is increased. Short barrel 7.62 x 51 mm weapons have substantial muzzle flash and blast, along with reduced terminal performance. 7.62 mm magazines require different size pouches than current M4/M16 LBE. In addition, several recent 7.62 mm weapon systems have not proven reliable or durable when subjected to combat conditions.



7.62 x 51 mm
147 gr M80 FMJ
(copper jacket)
at 2850 f/s
Note: The JSWB-IPT discovered that Lake City manufactured TWO different types of M80 FMJ over the last several decades. LC does NOT distinctly label the different M80 FMJ projectiles and the only way to tell them apart is to use a magnet
7.62 x 51 mm
147 gr M80 FMJ
(steel jacket)
at 2850 f/s
Note: Steel jacket M80 FMJ fragments down to 2800 f/s, at which point it begins to perform just like M80 copper jacket FMJ illustrated above
7.62 x 51 mm
175 gr M118LR
SMK OTM
at 2655 f/s
Note: M118LR offers very inconsistent terminal performance--sometimes fragmenting as shown, but other times penetrating deeply before yawing without fragmentation. In addition, M118LR tends to have poor performance against intermediate barriers, especially auto windshields
centimeters penetration
10
20
30
40
50
60
70


7.62 x 39 mm
120.5 gr M43 PS FMJ
(steel core)
at 2340 f/s
7.62 x 51 mm
155 gr TSWG
Hornady OTM
at 2850 f/s
7.62 x 39 mm
123 gr M67 FMJ
(lead core)
at 2300 f/s
7.62 x 51 mm
165 gr ATK Tactical
(barrier blind)
at 2675 f/s
centimeters penetration
10
20
30
40
50
60

How Can the U.S. Military Field More Effective Ammunition?

The most expeditious solution to improve terminal performance for current 5.56 mm carbines is to abandon M855 and adopt a consistent performing “Barrier Blind” combat load specifically designed for carbine use as the standard issue U.S. military 5.56 mm ammunition.

The ideal answer to upgrade current weapons and the clear choice for any new assault rifle is to adopt an intermediate caliber like the 6.8 mm, as this has proven to be the most efficient & effective choice in weapons with barrels 16” and shorter.

The final alternative is to field an improved 7.62 mm based system although for this to be of benefit, ammunition with performance dramatically superior to M80 ball, such as the TSWG 155 gr OTM or preferably, a new barrier blind load, needs to be standard issue.

NOTE: Current M995/M993 AP availability is too limited, especially for rifle and carbine use. It is critical to ensure that effective AP ammo is readily available on stripper clips for use in carbines & rifles, for ALL personnel potentially engaging in combat, just like GI’s had available for their M1 Garands and BAR’s in WWII. Abundant AP ammo availability may prove critical in potential future conflicts against modern, well equipped opponents wearing advanced body armor.

More than 100 years later, it may be time for Congress and the President to re-evaluate the outmoded and archaic 1899 Hague Convention's prohibition against routine combat use of the standard deforming ammunition commonly used by LE personnel. The Hague Convention's guidelines are no longer relevant for today's urban battlefield with its close intermixing of innocent civilians and irregular combatants.

The U.S. is not a party to the 1899 Hague treaty, but has complied with it in international armed conflict; as a result, the majority of U.S. military personnel are limited to using FMJ ammunition in combat. It is patently ludicrous to conclude that incapacitating dangerous opponents in combat while using the same deforming bullets legally relied on daily by LE agencies is somehow inhumane and unlawful, while wounding or killing the same enemy using much more powerful destructive ordnance such as grenades, mines, mortars, artillery, rockets, bombs, CBU's, FAE's, and thermobarics is approved and condoned. This is neither logical nor just and in fact does nothing to limit the severity of battlefield casualties.

In many respects, the use of deforming LE type ammunition during modern combat is far more humane, as accurate and effective ammunition reduces the need for multiple shots--decreasing the chance of shots missing the intended opponent and striking innocent civilians. Deforming projectiles also mitigate the potential of innocent bystanders getting hit by bullets which first perforate the target They may also reduce the number of times a dangerous opponent must be shot, potentially limiting the amount of surgical intervention needed to control hemorrhage.

It is time to move beyond the illogical prohibitions regarding modern deforming small arms projectiles in the antiquated 1899 Hague Convention and authorize all U.S. military personnel to routinely field the same deforming ammunition used daily by American LE officers, as it has consistently proven to be efficacious in rapidly stopping hostile actions by violent opponents and highly effective at protecting both friendly forces and innocent civilians.

Time for a Change

US "Incremental" Small Arms Fielding – Failures and Solutions

Part I - Small Arms
by Jim Schatz

052108

Introduction

- 2-part Presentation – Q&A's after Part II
  - Part I – Small Arms – Jim Schatz
  - Part II – Ammunition – Dr. Gary Roberts

- All parts "stand-alone" – author prepared

- Historic "Snap Shot" look at complex issues. Insufficient time available for a detailed look.

  Full briefing available on request.

- Part I – Excess Data for future reference

Purpose

- To create a national awareness and dialogue on serious small arms issues for US war fighters
- Not to cast blame
- To breach the deeply ingrained "institutional resistance" to "incremental" change
- To affect positive, permanent change ***now***
  - Current small arms and ammunition
  - In P&P to prevent repeated failures
- To persuade "the system" to test incrementally superior COTS small arms systems ***today!***

Pertains to more than just the one weapon type!

Goal

To find, test and field
the best small arms
and ammunition available
to the American war fighter
today and always!

Qualifications – Jim Schatz

- User: 11B – 82nd Airborne Division
- Trainer: US Army Marksmanship Unit
- Provider: 22+ years to the US Government, war fighter
  - Logistical Support
  - Contracts
  - Fielding
- Developer: HK416, M1014, USP, MP5/10, others
- Student: Of small arms since age ten
- Supporter: Of the end user

No direct affiliation with firearms or ammo makers.

Not the "lone voice" on this issue! One of many.

Caveats

- Not all services, organizations are the same
- The larger the organization, the less they support the true needs of the end user
- There are well intentioned people trying to do the right thing for the war fighter but are often smothered by entrenched bureaucracy
- Specific weapons, names, organizations omitted
- All data and claims supported by reference materials, public domain info and/or first hand knowledge

Definitions – Part I

- "War Fighters" "End Users" – current US ground combatants who engage the enemy with small arms
- "Select US Units" – Public domain. See "Army Times"
- The "System" – DoD organizations tasked weapons acquisition, testing, fielding and logistical support of US DoD small arms and ammunition. Contacted by author for comment. Included herein where possible.
- "US Standard" – current issue

Definitions – Part I

- “Incremental” Improvements
  - The “90% solution”
  - Available as COTS/NDI, modified COTS

  - Significant advantages for ***the end user!***
    > Reliability: 7X that of US standard
    > Service Life: 3 – 4X that of US standard
    > Improved Accuracy: 30-50% increase
    > Safety: OTB (2 vs. 6 sec. drain time), Increased (60%+) Cook Off (210-240 vs. 120-150 rounds), SBFA (catch live projectiles during blank firing)
    > Weight Reduction

Definitions – Part I

- “**Incremental**” **Improvements** (cont.)

- Significant advantages for <u>the end user</u>

> **Modularity, User Configurable, Controls: (SCAR, XM8, USP)**
>
> **Parts Commonality: 82% between 5.56mm, 6.8mm and 7.62mm (SCAR)**
>
> **Reduced Maintenance (user, maintainer): 72% less cleaning time (any Op Rod system)**
>
> **Reduced Procurement Costs: (complete weapons, barrels, piece parts)**
>
> **Reduced Life Cycle Costs: 45-75%**

Prime Example: Op Rod “No Brainer”

- **Operating Rod Gas Systems deemed superior**

  - Fielded with Select US Units and soon(?) USSOCOM
  - Fielded with OGA’s and Foreign Friendly nations
  - NLT 17 manufacturers offer op rod AR’s since 2004
  - NLT 2 available from current carbine producer
  - Superior performance in SCAR L, XM8, HK416 and ATEC Extreme Dust test (4 and 7X better)
  - Deemed superior by SME’s, experts, AR-15 designer

Yet the system still plans to release the current direct gas system carbine TDP for recompete in June 2009!

Prime Example:
Op Rod "No Brainer" (cont.)

- **The system presently has no mechanism or policy that automatically and regularly evaluates, in a detailed fashion and against current legacy weapons, available and emerging superior COTS, OGA, threat and foreign friendly incremental small arms innovations.**

Requirements are being written and lucrative multi-year procurements are being made without considering/including state-of-the-art <u>and available</u> incremental improvements!

Incremental vs. “Leap Ahead”

- **Ground combatants still kill the enemy with KE mechanisms (bullets, fragments) that must be:**
  - **Accurately aimed and delivered to the target by skilled operators (even AB munitions and LRF’s)**
  - **From belt buckle distance to MER**
  - **Same for all – Conventional, SOF, enemy**

- **The last “leap ahead” advancement in small arms – 14 century “Hand Cannon” (first KE firearm)**

- **The last substantial US “incremental” advancement in small arms was America’s first Assault Rifle the AR-15/M16 *more than four decades ago!***

“Leap Ahead”

“Leap Ahead” =

- Looking past available incremental advantages for the war fighter
- Incremental weapons stagnation
- Increased risk to the end user
- Decay in US small arms ingenuity
- Increased cost to tax payers
- Increased threat capabilities
- Irreversible damage to the American small arms industry
- Loss of respect for the US small arms system

NLT $430M spent since 1980 alone!

At Stake

"Most of the boots on the ground in OEF/OIF will be the first to tell you that the enemy has no respect for our war fighters in a head-to-head confrontation while maneuvering with his individual weapon.

An enemy who does not respect a Soldier's ability to deliver pain or death will always bring the fight directly to the Soldier, at belt buckle distance."

MSG Steve Holland – 5th Special Forces Group (ABN)

30 year Army veteran, NDIA Hathcock Award Recipient

At Stake

- **SGT Peralas – B Co. 2/504 PIR 82nd Abn Div**
  Afghanistan April 2005 – March 2006 (1)
  "I saw first hand what happens when your weapon jams up because of harsh environments we have to call home here. An 18B weapons sergeant was shot in the face due directly to his weapon jamming. I just cant believe that after things like this happen, the Army is still buying more (weapons)."

- **507th Maintenance Company (PFC Jessica Lynch)**
  An Nasiriyah, Iraq – 23 March, 2003 (2)
  - 33 soldiers ambushed by Iraqi troops
  - 11 KIA, 2 WIA, 6 POW's
  PFC Patrick Miller – Silver Star recipient.
  Repeated rifle failures drove him to surrender.
  Most weapons failed.

At Stake (cont.)

- **SSG Jason Fetty – US Army Reserve – Silver Star recipient**
  Khost, Afghanistan – February 2007 [3]

  "Staff Sgt. Fetty fired into his (suicide bomber) lower legs, then his kneecaps. He stood back up, even though I gave him a crippling wound". "He got back up and tried to come at me again". "He shot again at the man's stomach". "I abandoned all hopes of killing the guy before he would explode". "The blast came as he hit the ground, peppering him with shrapnel in the face, leg and ankle."

- **MSG Anthony Pryor – 5th SFG (ABN) – Silver Star recipient**
  Afghanistan mountains – 23 January 2002 [4]

  "…Pryor snapped his gun around and shot the terrorist at point blank range with two rounds of 5.56. The man crumpled." "So I went left to right, indexed down and shot those (two more) guys". "What he thought were their corpses sagged lifelessly to the floor". "I realized that I was halfway through my magazine, so I started to change magazines. Then I felt something behind me, and thought it was one of my teammates…". "The blow came suddenly. With stunning power." "He heard a noise, looked over and saw the ghostly apparition of the two men he had shot clamber back to their feet, fumbling for their weapons".

At Stake (cont.)

- **CPT Nate Self**
  Ranger Regiment –
  Silver Star recipient
  Shah-I-Kot Mountains, Afghanistan
  4 March, 2002 (5)

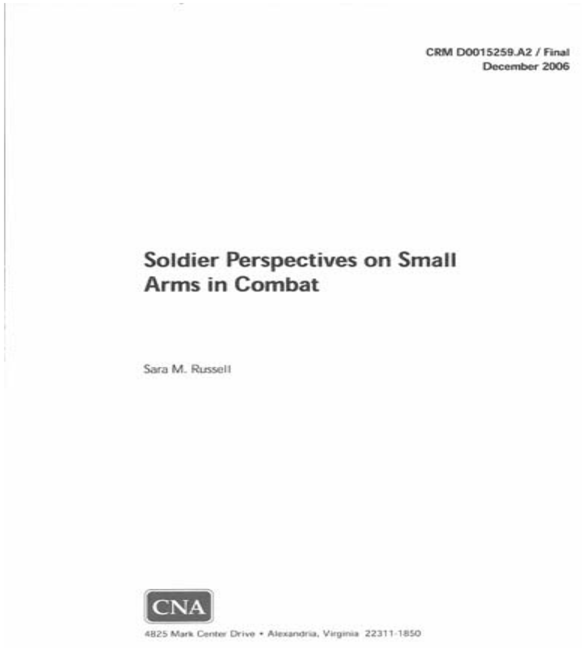
"Once behind cover, Self tried to fire again, but his weapon jammed." "I pulled my charging handle back, and there was a round stuck in the chamber." Like the rest of his men, Self always carried a cleaning rod zip tied to the side of his weapon <u>in case it failed to extract a round from the Chamber.</u>" "I started to knock the round out by pushing the rod down the barrel, and it broke off. There was nothing I could with it after that."

The Hidden Truth

The "Smoking Gun" – CNAC Survey

- CNA "Soldier Perspectives on Small Arms in Combat" Study - December 2006 (6)

  CRM D0015259.A2/Final - Sara M. Russell
  Center for Naval Analysis Corporation
  4825 Mark Center Drive
  Alexandria, VA 22311-1850
  Found at:
  http://www.defenseindustrydaily.com/the-usas-m4-carbine-controversy-03289/


CRM D0015259.A2 / Final
December 2006

Soldier Perspectives on Small Arms in Combat

Sara M. Russell

CNA
4825 Mark Center Drive • Alexandria, Virginia 22311-1850

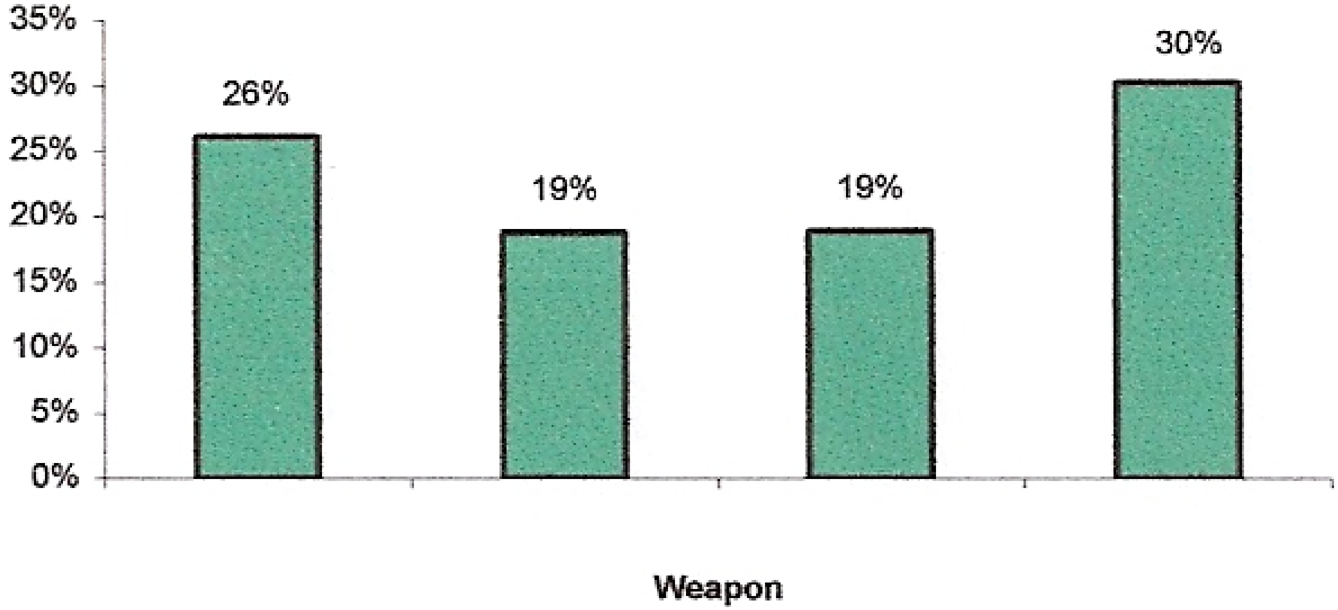
- Army Sponsored – Never published. Survey author told not to release information.

- 2,607 surveys taken from OIF/OEF veterans within 12 months of their return from theater.

CNAC Survey (cont.)

Page 17 – % of Weapon Stoppages

Figure 4. Percentage of soldiers who report experiencing a stoppage while engaging the enemy



CNAC Survey (cont.)

Page 17 – % of Weapon Stoppages (cont.)

a. These numbers reflect the response from the 541 (21 percent) of soldiers who experienced a weapon stoppage while engaging the enemy in theater.

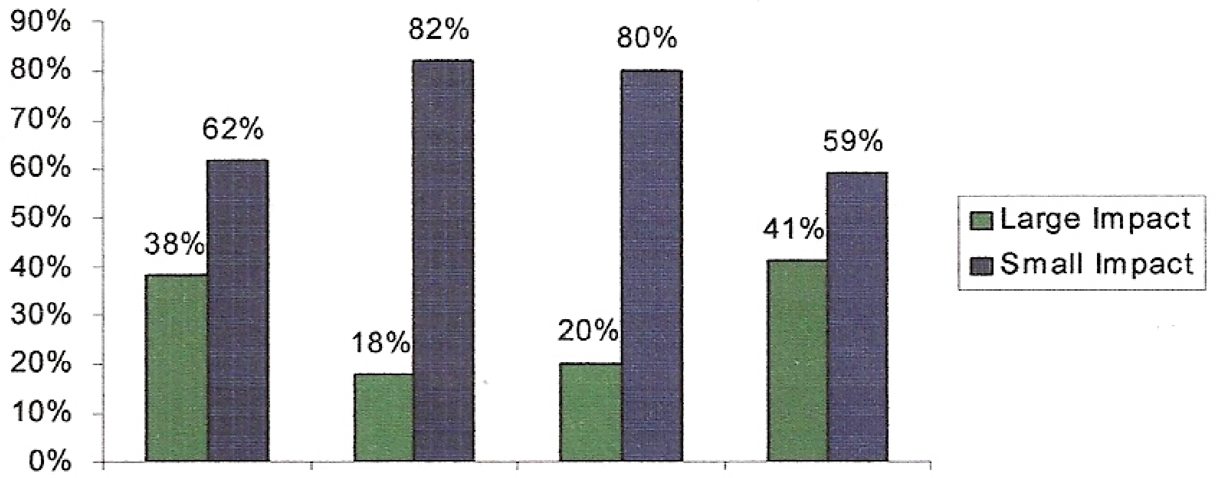
Small Impact – Ability to engage target with weapon after performing immediate or remedial action to clear the stoppage.

Handgun – 62%
Carbine – 82%
Rifle – 80%
SAW – 59%

CNAC Survey (cont.)

Page 18 – Impact of Weapon Stoppages

Figure 5. Impact of stoppages during enemy engagement[a]



a. These numbers reflect the responses from the 541 (21 percent) of soldiers who experienced a weapon stoppage while engaging the enemy in theater.

Small impact – Ability to engage target with weapon after performing immediate or remedial action to clear the stoppage.

Large impact – Inability to engage target with weapon during a significant portion or entire firefight after performing immediate or remedial action to clear the stoppage.

CNAC Survey (cont.)

Page 18 – Impact of Weapon Stoppages (cont.)

Large Impact – Inability to engage target with weapon *during a significant portion or entire firefight* after performing immediate action or remedial action to clear the stoppage.

Handgun – 38 %

Carbine – 18%

Rifle – 20%

SAW – 41%

29.25% Average!

CNAC Survey (cont.)

- **While quick to ask the soldiers if they were "satisfied with their weapons"(78% positive, *<u>but with a limited soldier point of reference</u>*), the survey never asked those who reported stoppages in firefights:**
  - **Did injuries or deaths result?**
  - **Was the mission compromised as a result?**
  - **Did the enemy escape or threaten friendly forces as a result?**

Any formal process for the end user to report weapon failures is unknown to the end users!

CNAC Survey (cont.)

- **544 weapon stoppages reported out of the 2607 surveys collected – <u>a 21% average failure rate</u>**
- **A full one-fifth of soldiers placed at risk due to weapon failures while engaging the enemy! How many fatalities resulted?**
- **Official Army News Release 29 May, 2007: *"Soldiers reported overwhelming satisfaction with their (weapon)!"*** *(7)*

System leadership terms soldier reports "emperical"

How many soldiers today are carrying weapons that will fail when called upon to perform? <u>21%?</u>

"This has been a sore point for me for some time. Soldier's have no clue what else is out there. I can tell you first hand from looking around where I work everyday, those with (rifles) are the wretched refuse - the non-"in" crowd. Those with (carbines) are the cool troops.

Quite simply the (carbine) is so popular and desired among the troops because it is so much handier to carry around.

99% of the weapon time over here is lugging it from place to place 24/7.

Make no mistake ease of carry is the reason most Soldier's love their (carbines)."

US Army LTC (Infantry) – Iraq - May 2008

Our Aged Fleet

“The United States military is in bad shape because they’ve let these small arms deteriorate to a point now where the US is a superpower only when it fights in a naval or an air battle.

It’s not a superpower when it fights a rifle battle.”

Mr. James Sullivan

2001 NDIA Chinn Award Recipient

Designer: AR-15/M16, Stoner 63, Ultimax 100, Mini 14, Beta Magazine

The Cause – Our Aged Fleet

The "Big 8" – Primary US Military Small Arms						
Weapon	**Year First Fielded** [1]	**Age (Years)**	**Manufacturer**	**Modern Design Available**	**Replaced by OFW candidate**	**Comments**
M9 Pistol 9x19mm	1985 (Army)	23	Beretta USA	Beretta Brigadier, PX4, others	No	Numerous modern alternatives abound, to include PDW calibers
M4 Carbine 5.56x45mm	1994 (Army adoption)	14	Colt Defense	Colt M5, XM8, HK416, SCAR L, others	No	Modern Op Rod designs
M16A1 Rifle 5.56x45mm	1967 (Type classified by Army)	41 [2]	FNMI, Colt Defense	FN SCAR, F2000 Colt M5, HK416, XM8	No	Modern Op Rod and/or bull pup designs
M203 Grenade Launcher 40x46mm	1969	39	Various	US XM320	No	3+ years since COTS contract award
M249 Squad Automatic Weapon 5.56x45mm	1982	26	FNMI	FN MK46	No	MK46 fielded with USSOCOM
M240B Medium Machine Gun 7.62x51mm	1976 (Army)	32	FNMI	FN MK48, Vector SS77, US Ord. M60E4, Barrett LW240, HK121	No	MK48 fielded with USSOCOM
MK19 MOD 3 Automatic Grenade Launcher 40x53mm	1988 (Army)	20	GD	GD MK47, HK GMG	No	MK47 and GMG fielded with USSOCOM, OGA's
M2HB Heavy Machine Gun .50 BMG	1923	85	GD	GD M2E2, GD XM312	No	
	Average:	**35**	**All eight weapons above**			
	Average:	**28**	**Without M2HB**			
	Average:	**26**	**Without M2HB and M203**			
	Average:	**23**	**Without M2HB, M203, M16**			

"OFW" - Objective Family of Weapons from "Small Arms Master Plan" (SAMP) first briefed in 1984 by the USAIC.

(1) All initial fielding dates taken from "Jane's Infantry Weapons, 2007/2008 edition. (2) America's longest serving service rifle.

The “Big 8” – Showing their Age

Average: **35** All eight weapons

Average: **28** Without M2HB

Average: **26** Without M2HB and M203

Average: **23** Without M2HB, M203, M16

- Trickle Down” effect. What the system buys often ends up in:
  - All branches of our military
  - US State Department/Embassy security
  - OGA’s (federal law enforcement, DOE, NRC, FBP, other)
  - State and Local law enforcement
  - Foreign Military Sales (FMS)

Small Arms “Disconnect”

- While US small arms remain fundamentally unchanged in regards to performance, the same does not apply to other and <u>often more costly</u> (3-8 X) equipment items.

- Behind water and rations, small arms rank third as the most important piece of individual equipment to the war fighter. Yet we fight today with on average Vietnam-age small arms and ammunition. Do we have the best available? Is there better out there? How will we know if we don’t look? Others have.

Small Arms “Disconnect” (cont.)

- Night Fighting Equipment
- Helmets and suspension
- Load bearing equipment
- Uniforms, boots, gloves
- Body Armor
- Eye, Ear Protection
- Rations, water carriers
- Communications gear
- Cold/wet weather gear
- First Aid pack, gas masks
- Anti-tank weapons

20 years Ago

2008

Weapons designed in the 1960’s, *or earlier!*

"We buy new laptop computers every few years across the gamut, so couldn't we do the same for our single most important piece of equipment? Are the lives of those in our most elite units of any more value than the lives of those individuals who drive trucks on the battlefield, who purify water, who cook our grits?"

Major Chaz W. Bowser
Former Weapons/SCAR Combat Developer
US Army Special Operations Command

System "Fast Track" Fielding

Item	Years in Pipeline	Status
• COTS XM26 MASS	> 10	FUE FY09 (14)
• COTS XM320 GLM	> 4*	FUE 2QFY09 (15)
• COTS XM110 SASS	> 2**	FUE CY08
• M240E6	> 11	FUE 3QFY10
• OICW/XM25	> 17	Pending
• OCSW/XM307/312	> 13	Pending

* Since contract award (05/05)

** Since RFP release (03/06)

Success Stories

The German Success Story

German Military Small Arms Fielded….. *all since 1994*								
#	Weapon	Year First Fielded	Age (Years)	New Weapon	New Capability	Unique Capability	New Caliber	Comments
1	P8 Pistol – 9mm	1994	14	Yes	No	No	No	*First general military issue PDW caliber pistol – planned fielding after 2009.
2	P12 Pistol - .45 ACP	1998	10	Yes	Yes	No	Yes	
3	P46 – 4.6mm	*Pending		*Pending	Yes	Yes	Yes	
4	MP 7 PDW [1] 4.6mm	2002	6	Yes	Yes	Yes	" "	[1] First general military issue PDW in NATO.
5	G36 Carbine 5.56mm	1998	10	Yes	Yes	No	Yes	Modern Op Rod design
6	G36 Rifle 5.56mm	1997	11	Yes	Yes	No	" "	Modern Op Rod design
7	G22 Sniper Rifle .300 Win Mag	1998/99	10	Yes	Yes	No	Yes	
8	G82 Sniper Rifle .50 BMG	2005	3	Yes	Yes	No	No	Modified Barrett M82A1
9	AG36 Grenade Launcher 40x46mm	2001	7	Yes	Yes	No	No	COTS variant of US XM320. Fielded in USSOCOM, OGA's, UK, Spain, Norway, etc.
10	MG4 LMG 5.56mm	2005	3	Yes	Yes	No	Yes	Demonstrated 100K round weapon, barrel service life.
11	Grenade Machine Gun - 40x53mm	2002	6	Yes	Yes	No	Yes	Also fielded with USSOCOM, OGA's, UK, Norway, etc.
			8	10	10	2	6	

The Answer – Incremental Fielding

German small arms successes ***all since 1994***

- 10 new (of 13) small arms fielded
- 10 new weapon capabilities fielded
- 2 unique capabilities (1st general issue PDW)
- 6 new calibers fielded
- Worlds most reliable op rod carbine fielded
- Family of rifles/carbines/LSW fielded
- Lower per capita defense budget than the US and most of Europe
- Similar incremental success in UK, Spain, Norway, Canada, Mexico, Turkey, China, Russia, elsewhere.

US SOF Success Story

- **User driven, user tested, user selected**
- **Even faster fielding model in Select US Units**

Select US Unit Success

- **Have replaced 7/8 US standard weapons with incrementally superior COTS weapons – 90% solution**
  - **In near term (< 2 years)**
  - **Few if any R&D dollars spent – low risk to vendors**
  - **Advanced and unique capabilities fielded – *ALL COTS!***
    - **> FN Minimi before M249**
    - **> MAG58 before M240**
    - **> MK19 in Navy Spec War in 1960's**
    - **> .50 caliber Sniper Weapons before M107**
    - **> SR-25 before M110**
    - **> AG416 before XM320**
    - **> .40 S&W caliber handguns years before JCP/CP/MHS**
    - **> PDW caliber weapons and ammo**
    - **> HK416/417, GMG, SCAR/EGLM, others**

Most fielded with limited US Govt R&D spending, *if any!*

Select US Unit Success (cont.)

- **Also uniforms, visual augmentation, protective gear, etc.**

- **Model small arms acquisition that *can and should be replicated <u>for all US military war fighters ASAP!</u>***
  - **User driven, tested, selected**
  - **Realistic requirements!**
  - **Pushing the envelope of COTS**
  - **Less cost to the tax payer**
  - **Enhanced war fighter confidence, safety, survivability**

Threat Successes

Russian AN-94
“Shifted Pulse”
Assault Rifle
5.45x39mm
pH doubled @ 1800 rpm ROF
In limited production and fielding since 2001. Being developed in 7.62x39mm.

The System has nothing that competes with these weapon capabilities!

Chinese QBZ-95 Family of Weapons
5.8x42mm Superior cartridge/bull pup ammunition performance.
First fielded in 1998.

Russian GSh-18 Armor Piercing Semi-automatic Pistol.
9x19mm PBP.
First fielded in 2000.
Penetrates 8mm mild steel or Class III body armor at 20 meters.

Threat Successes (cont.)

Iranian KH2002 Bull pup Assault Rifle
5.56x45mm **First fielded in 2004.**
Increased terminal effects due to bull pup MV increase.

Russian SR-1 Gyurza Armor Piercing Semi-automatic Pistol
9x21mm SP-10, SP11, SP-12 **Adopted in 2003.** **Penetrates 2.8mm Titanium and 30 layers Kevlar at 100 meters.**

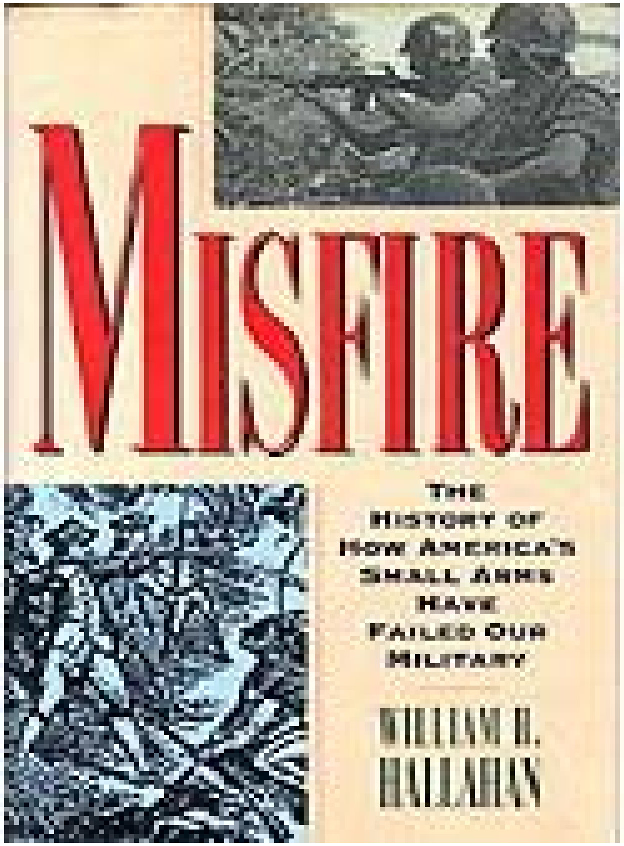
Russian "VSSK" Silenced Sniper Rifle
12.7mm Special Subsonic
First fielded in 2002.
Defeats 16mm steel plate at 200 meters.
US NIJ Class III at 100 meters.

The System has nothing that competes with these weapon capabilities!

A Long, Sad History of Ignoring the War Fighter

More of the Same Shame

- Current “dysfunction” reoccurs @ every 30-50 years
- Top Driven, enabled
- War fighter ignored
- Incremental advancements ignored



- Required reading: *“Misfire”*

The history of how American small arms have failed our military” By William H. Hallahan. Available from amazon.com

Summary available. Send email to presenter.

More of the same (cont.)

- ***Always results from a system/individuals unwillingness to address the specific requests of the war fighter!***
- **Requires direct media, SECWAR/DEF, Congressional, POUS intervention to remedy.**
  - **1777 – "US Ordnance Corps" founded at Springfield, MA**
  - **1854 - Franklin Piece – restored civilian control of armories.**
  - **Abraham Lincoln twice (1861 – Sent for Union arms from Europe, 1863 – pushed for Spencer carbines)**
  - **1901 – Teddy Roosevelt – forced leadership change at Springfield Armory**
  - **1914 – SECWAR Baker orders complete overhaul of "Ordnance Bureau"**
  - **1916 – Woodrow Wilson Presidential campaign (Lewis Gun controversy)**
  - **1962 - John F. Kennedy – direct involvement in AR-15 fielding**
  - **1967 - US "Ordnance Department" disbanded/ restructured by SECDEF McNamara after stalling on AR-15 production**

More of the same –*TODAY!*

- ***We are at that time in history again!***

  - Our small arms are aged and no longer state-of-the-art.
  - Troops and Commanders are not getting what they are asking for.
  - Decisions on small arms are happening far from the front lines.
  - Superior weapons are being taken from troops by those unqualified to do so (AWG).
  - Limited funds are being squandered on useless small arms "ventures."
  - The system irrationally and irresponsibly hides facts and then fights any and all changes.
  - With few exceptions the best new small arms are coming from foreign sources.
  - *Weapons are failing in combat and lives have been placed at jeopardy as a result!*

American Revolutionary War (1775 – 1783)

- **American forces armed with muzzle loading British "Brown Bess" and "Charleville model 1763 Muskets" (2 shots per minute, unrifled bore)**
- **Breech-loading "Ferguson Rifle" demonstrated 4-6 shots per minute during 27 April, 1776 demo in England. 200 man British unit formed and excelled against a much larger force at the Battle of Brandywine, Sept. 1777.**

Lesson forgotten by the US Ordnance Corps after the war's end!

War of 1812
(1812 to 1814/15)

- **1811 – John Hall invents breech-loading "rifle" with:**
  - Rifled bore for increased (2-3 times) range and accuracy over muskets
  - Interchangeable parts (versus hand fitted which was the norm)
  - Was deemed "superior by every other kind of small arm" by US Army Rifle Test Board.

- **America enters another war with the Charleville model 1763 Muskets (2 shots per minute, unrifled bore)** ***36 years after the British had proven the breech-loading Ferguson Rifle superior in battle!***

Missed opportunities

- **1816 – All-weather percussion cap invented and first used in Europe.** ***First field in the US 26 years later in 1842!***
- **1827 – Congress directs SECWAR to investigate the failure of the US Ordnance Corps to manufacture and field a breech-loading rifle** ***16 years after the Hall Rifle was offered and 50 years after the Ferguson first killed Americans in 1777!***
- **1836 – Repeating rifles from Hall tested again, along with samples from Cochran, Colt and Hackett. Hall rifle judged best. US Ordnance Corps opined** ***"the complex mechanism of breech-loading weapons deranges and perplexes the soldier."***
- **1840 – First bolt-action "Dreyse Needle Gun" repeating rifle designed and fielded in Germany.**

More Missed Opportunities

- **1841 – Muzzle-loading US Charleville musket *turns 80, still in US Army service!***

- **1845 – US Army goes to war against Mexico, mostly armed with muzzle-loading US percussion cap (not all-weather cap) *rifles 29 years after Europe first used all-weather percussion caps!***

American Civil War
(1861 – 1865)

- Confederate Calvary used mostly Hall model 1843 breech-loading rifles. Union forces fought with mostly Springfield model 1855 muzzle-loaders.
- Henry, Marsh and Sharps rifles mostly ignored by the US Ordnance Corps. Experts believe they could have shortened the war by giving the Union troops superior firepower.
  - Henry – Tube-fed, lever-action repeater firing copper-cased cartridges (>15 rpm).
  - Marsh – Converted Springfield model 1855 with trap-door (6-8 rpm).
  - Spencer model 1860 – 7-shot, tube-fed, lever-action, metallic cartridges (21 rpm)
  - Sharps – Single-shot, breech-loader, paper/linen cartridges (8-10 rpm). Personally tested by President Lincoln himself – summer 1861. *Chief of Ordnance General Ripley repeatedly and for years defied the President's direction to test and field a repeating rifle!*

More of the same

- 1863 (24 June) - Commanding Officer Wilder's "Lightning Brigade", Union Infantry, at Union Gap battle, armed with Spencer repeaters. Out numbered 4/1 by Bushrod Johnson's confederate unit. Four confederate attacks, all repelled by the Spencers. Wilder lost 51, Johnson 156.

  US Ordnance Corps refused to provide the requested Spencers. Wilder got promissory notes for $35 from each of his men, borrowed the money from a bank and purchased the Spencers direct from the factory in Boston. After the battle the War Department reimbursed the troops for their Spencers!

- 1865 – Springfield Armory Rifle Board Field Trails – 108 rifle models submitted, including 10 repeaters and 10 bolt actions. ***The board "selected" the single-shot Springfield model 1873 trap-door rifle!***

1866 - Indian Uprisings Begin

- **1871 – German Mauser Company develops model 71 bolt-action repeating rifle, later redesigned with a clip-chargeable internal magazine.**

- **1875 – Last of the repeating rifles pulled from service by the US Ordnance Corps.**

- **15 June, 1876 – General George Armstrong Custer and 650 Calvary armed with single-shot Springfield model 1873 trap-door rifles (Custer left behind 2 Gatling guns) ride up the Rosebud river to the mouth of the Little Big Horn valley to 1,500 Sioux waiting with Henry, Spencers and Winchester repeaters. *All 650 soldiers died!***

More Missed Opportunities

- 1887 – First Maxim Machine Guns ("Devils Paintbrush") appear and are quickly adopted by the British, Russians, Turkey, many others. Used with devastating effect by the Germans against the British in 1899 during the Boer War and during the Russo-Jap War in 1904-05, 27 years before World War I began.
- 1888 – US Ordnance Corps ***tests and rejects the Maxim Machine Gun!***
- 1890 – 1st model Springfield Trap-door single-shot rifle, second longest serving US service rifle (besides the AR-15/M16/M4 @ 43 years) retired from service after 25 years:
  - ***50 years after the first bolt-action repeater was fielded in Germany!***
  - ***47 years after the first Hall repeater was designed!***

More Missed Opportunities

- **1891 – US Army Ordnance Corps Rifle Board solicits industry for new rifles for trails. *Not one US design submitted!***
- **1892 – US adopts Danish Krag-Jorgensen with single-load chamber for the .30-40 Krag with round nose projectile, *after 5 reworks!* *Most every European country turned it down due to its weak design and magazine type!***
- **1898 (1 July) – Battle of San Juan Hill, Cuba**

  5,000 Americans armed with Krag's engage 700 Spaniards armed with 7mm Mauser bolt-actions firing smokeless-powder "spitzer" bullets.

  1,300 Americans died!

First World War (1914-1918)

- **1901 – Browning Machine Guns and the BAR offered to US Ordnance Chief General Crozier.** ***<u>Not used until 1918, 17 years later</u> and <u>months before the wars end!</u>***

- ***<u>Regardless of the brilliance of US-born small arms designers (Browning, Lewis, Maxim, etc.)</u>***

  <u>the US entered WWI with:</u>

  - <u>Unreliable French Benet-Mercie M1909 and Chauchat ("Show-Shaw") machine guns</u>

  - <u>British P14/17 rifles</u>

- ***<u>1916 – The US had still not formally selected a machine gun; 29 years after the first Maxims were already killing masses on battlefields all over the world!</u>***

Missed "Medium Caliber "Opportunity – Top Driven Mistakes

- **1918 – 1st model John Cantius Garand semi-auto rifle developed.**
- **1918 – J. D. Petersen develops .276 Pedersen cartridge and automatic rifle – 42% less recoil than .30 caliber rifle/cartridge.**
- **1928 – Infantry Board (30 April) and "Semi-auto Rifle Board" (July) recommends replacing .30 caliber M1903 bolt-action with .276 caliber, 125 grain bullet firing auto-rifle.**
- **21 Feb. 1929 - The .276 cartridge is approved for issue.**
- **1932 – Semi-auto Rifle Boards 3rd test – the .276 caliber semi-auto Garand T3E2 rifle is selected!**
- **1932 - Army COS Douglas McArthur *reverses decision on T3E2 fielding after 13 years of testing!***
- **<u>Nov. 1935 – 9.5 pound .30 caliber M1 Garand adopted</u>**

<u>*32 years after the 1903 bolt-action rifle was adopted!*</u>

Second World War
(1939-1945)

- **1 Sept. 1939 – Germany invades Poland – US is producing 100 M1 Garands per day. The first time in history where the US Army has the lead with a service rifle going into a war.**

  ALL because of John Garand's tireless efforts and genius!

- **Congress repays John Garand by dropping him from the Armory payroll (*a whopping $3600 a year savings to Uncle Sam!*)**

- **1942 – Germany develops the first assault rifle; MKb42. Fires a new 7.92x33mm Kurz Patrone "intermediate" cartridge at 400 rounds/minute. Lighter, cheaper and easier to make, less recoil, 2-3X combat load, detachable 30-rd magazine, select fire, straight line stock design.**

  - 7 years before the first AK-47 is fielded!

  - 15 years before the US M14 is fielded!

  - 20 years before the first AR-15's were issued in Vietnam!

German Successes Ignored

- Nov. 1992 – German “Kampfgruppe Scherer” surrounded by Russian forces on the Russian front. German Luftwaffe drops MKb42’s to the vastly outnumbered unit. German unit breaks out to fight another day. Credit given to the use of the MKb42 in its first appearance on the battlefield.
- 1943-1944 – By this time Germany was producing 400K MP44 Assault Rifles per year. Given one more year the entire German military could have been armed with MP44’s.
- 1945 – American Ordnance experts at Mauser plant – collect drawings and samples of MP44, Gerot 03 and 06 rifles.

Hard Lessons Learned – Anyone Listening?

- **1947 – WWII study by General S.L.A. Marshall “Men against Fire” released. Gen. Marshall writes “most officers had little or no knowledge of how their men fought individually that when interviewed knew that as few as 15/100 were doing all the fighting”. *“The least knowledgeable would be the highest ranking men in the Army and in the place most distant from the battlefield: the Pentagon.”***
- ***1947 – British “Beeching” report is published. Maximum effective rifle cartridge range in combat is 600 yards. .28 caliber deemed ideal (recoil, lethality, weight). 18 years after the US develops, approves and then mothballs the .276 Pederson cartridge and rifle!***

The Russians were Listening

- **1947 – Mikhail Timofeyevich Kalashnikov designs the first "Avtomat Kalashnikov" which was to become the AK-47; the most commonly encountered assault rifle on the planet. Estimates are that more than 9M AK's have been produced.**

- **1949 – AK-47's first fielded with Russian troops** ***13 years before the US issues its true first assault rifle (the AR-15) to the USAF and 18 years before the AR-15/M16 is adopted by the US Army!***

Korean Conflict (1950-1953)

- ***Beeching, Hall, Hitchman reports all agree on the maximum effective range of small arms in combat is NGT 300 meters (average 120 meters). Mirrors wartime findings of Germans and Russians that lead to the development and successful fielding of the MP44 and AK-47.***
- ***Yet in 1960 America fields the non-select fire M14 rifle that fires a full-power .30 caliber cartridge with excessive range and recoil and is uncontrollable on full auto fire!***
  - ***- 18 years after the MKb42 was fielded!***
  - ***- 11 years after the AK-47 was fielded!***

Korean Conflict (cont.)

- **1953 – US forces 7.62x51mm cartridge on NATO.**

- **19 Sept. 1958 – Infantry Board "CONARC" report finds "AR-15 more reliable (compared to the M14) under simulated combat conditions – which is a rifles most essential attribute".** ***Second such official finding.***

- COTS AR-15. Developed in 9 months.
Combat load 650 rounds. Weight 6.35 lbs. Select-fire.

- US Ordnance System M14. Developed in 12+ years.
Combat load 220 rounds. Weight 9.32 lbs.
Semi-automatic only (90% issued without full auto selector switch).

Vietnam Conflict

- **1958 - .258 caliber (between .22 and .30 caliber) AR-15 proposed by US Army. Eugene Stoner to design it. *Cartridge never completed by US Ordnance Department.* Effort dropped.**

- **Nov. 1958 – Feb. 1959 – Full comparative tests of AR-15 and M14. AR-15 far "out distances the M14 in overall combat potential". CDEC personnel recommend early retirement of the M14. *Third such official finding.***

Vietnam Conflict (cont.)

- Feb. 1959 – ***General Taylor orders no additional AR-15 purchases and full-scale M14 production.*** 1st commercial contract for M14's is issued to Winchester.

- 1960 – First M14's produced ***3 years after adoption!***

- June 1960 – US Ordnance Dept. refuses to retest AR-15 due to ***"the lack of any military requirement for such an arm."***

Vietnam Conflict (cont.)

- **27 Sept. 1962 – Charles Hitch (DOD Comptroller) releases “Hitch Report”. AR-15 outclassed M14 in all areas. Production cost/ease, performance, basic combat load. M14 found inferior to M1 Garand and AK-47. AR-15 firepower found advantageous for US troops over AK-47.**

- **15 May 1963 – Springfield Armory changes rifling twist from 1/14” to 1/12” to increase helmet penetration but which reduces also lethality by 40%, *just in time for Vietnam!***

Vietnam Conflict (cont.)

- **March 1964 – USAF receives first "M16's".**

  May 26, 1964 – US Army receives first "M16E1's".

  NO CLEANING KITS ISSUED! (And would not be in quantity for almost 2 years!)

- ***5TH WARNING (of 6) – Winter 1965/66 - Fort Ord tests of M16, AK-47 and M14. Report states:***

  "3 years of development (by the Ordnance Dept. of the M16) has done more harm than good."

Vietnam Conflict (cont.)

- **Oct. 1966 – Reports of M16 failures in battle – *troops dying!***
- ***2 years have passed since problems were identified* and cleaning kits recommended!**
- **1966 - American troops order "Dri-Slide" lubricant from family and friends in the US. *Reports of 70% failures to extract in M16's found with dead US GI's!***
- **32 of 80 USMC rifles failed in combat.**

Vietnam Conflict (cont.)

- **Fall 1969 – US Army formally adopts M16A1 and 5.56x45mm cartridge, and for use in Europe.**

- 27 years after the German MKb42 was first fielded!

- 20 years after the first AK-47 was fielded!

- 15 years after the AR-15 was first developed by Armalite!

- 11 years after the first successful US Army tests of the AR-15!

- 8 years after the first USAF and CDTC requests for AR-15's!

- 6 years after official M16 production begins!

- 5 years after the first M16's and M16E1's were fielded in Vietnam!

Vietnam Conflict *and Today*

- **7 May – 10 Oct. 1967 - Ichord Congressional Subcommittee formed to investigate M16 issues/combat failures** ***(Mirrors Congressional involvement today!)***

  - Chief of Ordnance COL Yount blames problems on troop maintenance. ***(Like Today! 507th BN)***

  - Troops were told to "tape a cleaning rod to the rifle and never leave a cartridge in the chamber overnight!" ***(Like CPT Nate Self in 2002!)***

  - 89M rounds of ball powder were fired before the Army acknowledged it was the primary cause of stoppages in the M16. ***(Still used today!)***

  - Ichord Committee blames problems on the Ordnance Department, specifically due to their failed AR-15 "conversion" to the M16.

Post Vietnam

- **1982 - America adopts the worlds only national service rifle without a fully automatic mode of fire (M16A2 w/ 3rb only)**

- **1985 – US adopts 9mm M9 Pistol to replace combat - proven .45 ACP M1911A1 Pistol.**

  38% stoppages reported in combat (2006 CNAC Survey) [6]

- **1994/95 – US adopts the M240G/B to replace the M60.**

  6.2 pounds (24%) heavier. No other weapons tested.

  The only weapons considered were those already in the inventory!

Post Vietnam (cont.)

- **1984 – "XM-4" Carbine Program initiated by the US Army.**
- **1986 – Army withdraws funding – USMC picks up project.**
- **1987 – USMC M4 Fielding Decision made**
- **1989 – Army interest in M4 is renewed**
- **1994 – 1st M4's fielded in the US Army *after 10 years!***

Post Vietnam (cont.)

- **Today - US Service Rifle "dumbed down" to short-barrel carbine length performance compromise by carbine "pure fleeting"**

  - Reliability (2002 USMC test) [19]

  - Max. Eff. Range (500 vs. 600 meters – point targets) [18]

  - Muzzle Velocity (3050 vs. 2750 fps)

  - Muzzle Energy (1765 vs. 1645 j)

  - Accuracy

  - Penetration

  - Terminal Effects (150 m. max. with M855) [17]

Never before in US history has the rifle been fully replaced with a carbine with front line combat units!

For those who say this problem is "old news"

- **Returning OIF Soldier Testimonials from 2008**

- Easy to obtain, if you ask. The Army has no process to collect shooting failure data!

- 7 failure accounts while in combat collected from 21 soldiers polled (33% - on par with CNAC survey), all seasoned combat veterans, most with multiple tours in OIF/OEF.

- Notice these are the enlisted men doing the fighting and reporting the problems – *those furthest from the small arms decision making process!*

For those who say this problem is "old news" (cont.)

- **Returning OIF Soldier Testimonials from 2008**

"During my deployment from Jan 07' to March 08' I had numerous failures to extract with my XXX. One such incident was during an engagement where we took sniper fire. My extractor was only a few months old but wouldn't extract after about 20 rounds. I took remedial action taking me out of the fight for about 3 minutes. Another time I tried to fire a controlled pair for a warning shot and it did not extract the round causing vehicles to get close to our formations"

SPC. B

For those who say this problem is "old news" (cont.)

- **Returning OIF Soldier Testimonials from 2008**

"In summertime, 2006, my XXX failed to extract/eject in a firefight with the Taliban. The weapon had just been through a thorough cleaning that morning. I performed immediate action, cleared and reloaded, the weapon fired one round and again, failed to extract/eject. I repeated the process with the same results during the duration of the firefight."

CPL B.

For those who say this problem is "old news" (cont.)

- **Returning OIF Soldier Testimonials from 2008**

"While serving in Iraq on a Provincial Reconstruction team security mission in and around the city of Tikrit my team was perimeter security on the actual building itself. My team and I moved to a guard tower outside the building to pull security. While pulling security I noticed a man peeking around a corner and looking in my general location. He did this once or twice and on the third time I had already placed my weapon from safe to semi and aimed my XXX at the corner. When he came around holding his AK-47 we fired at each other simultan-eously. I tried to pull a controlled pair but the round from the first shot did not extract. After performing SPORTS on my weapon the target was gone."

SGT V.

Politics over Lives

"The 110th Congress doesn't even care. They don't care that the (weapon) has got exactly the same problems that this thing had in '67. Back then people raised all kinds of hell over it. The 110th Congress doesn't do a damn thing,

and those soldiers over there in Iraq right now have exactly the same problems with their (weapons) in spite of the improved buffer."

Mr. James Sullivan
2001 NDIA Chinn Award Recipient
Designer: AR-15/M16, Stoner 63, Ultimax 100, Mini 14, Beta Magazine

User requests ignored

- **March 2004 - 3rd ID ONS for Integrated Modular Assault Weapon System" – *died with XM8!***

- **2005 and 2006 – 10th SFG (A) CMNS for 10" Op Rod Uppers – 2 requests - *never acted upon!***

- **March 2007 - 1st SFG (A) Procurement for 84 10" Op Rod Uppers – *cancelled by higher headquarters due to "program conflict!"***

User requests ignored (cont.)

- **2006-Present - Urgent CMNS from 5th SFG for 6.8mm SPC caliber CQBR PMOD** ***not acted on by higher headquarter's!***

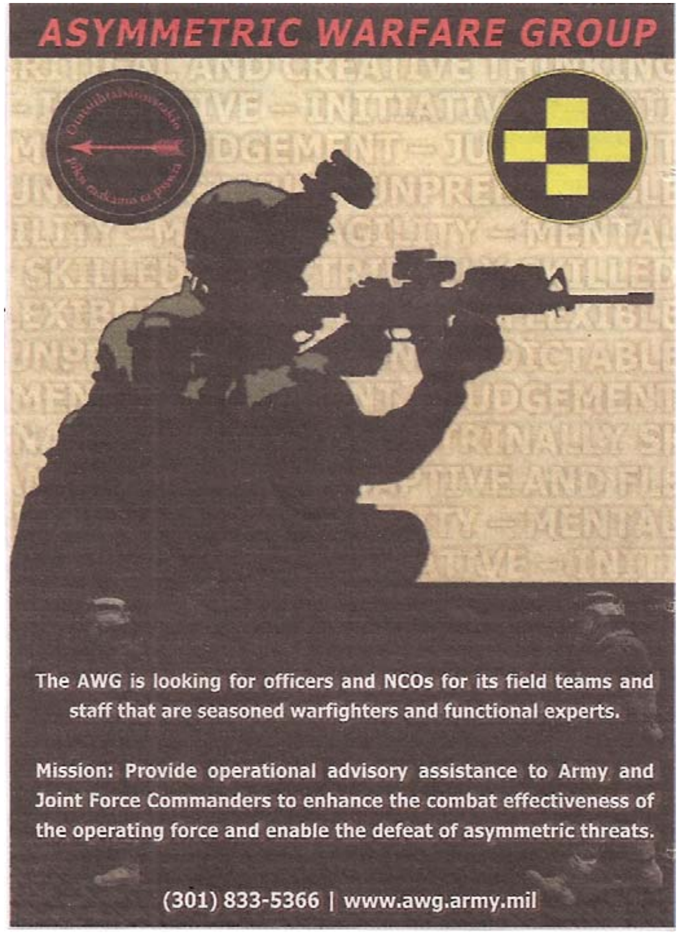
- **2005-Present - XXX DIV request for DM rifles.** ***No action to date!***

- **2006-Present – Modular Handgun System Program –** ***held up by "system dysfunction" for years!***

User requests ignored, *and worse!*

And Worse - **December 2007 Army leadership directs that superior HK416 carbines, in use with zero issues/breakages since August 2005 (and Glock pistols) be removed from the Asymmetric Warfare Group**

Real Reason: Other units asking for similar advanced capabilities!



Mission: Provide operational advisory assistance to Army and Joint Force Commander to enhance the combat effectiveness of the operating forces and enable the defeat of asymmetric threats

EXCEPT FOT SMALL ARMS!

User Request Process.
Death by a thousand cuts!

- **The End User/War Fighter requirement must navigate an endless and often insurmountable maze of bureaucracy to successfully realize an Urgent Mission Need Statement.**

- Unit
- BCT
- Division
- Corps
- Command
- Proponent
- DA
- Joint Services

And back again. ***Few survive!***

System R&D "Dysfunction"

"The fact of the matter is that technology changes every 10 or 15 years and we should be changing with it. And that has not been our case. We have been sitting on this thing for far too long."

"Our bureaucracy failed our troops."

"Holding a competition is the only way for the Army to make sure soldiers still have the best weapons available!"

GEN. Jack Keane – Former US Army VCOS

System R&D Dysfunction

- Constant Shift in Direction

  - Multiple/Micro Bullets, Flechettes - 1960's, 1970's (Projects SALVO, SPIW)
    Millions spent – nothing fielded!

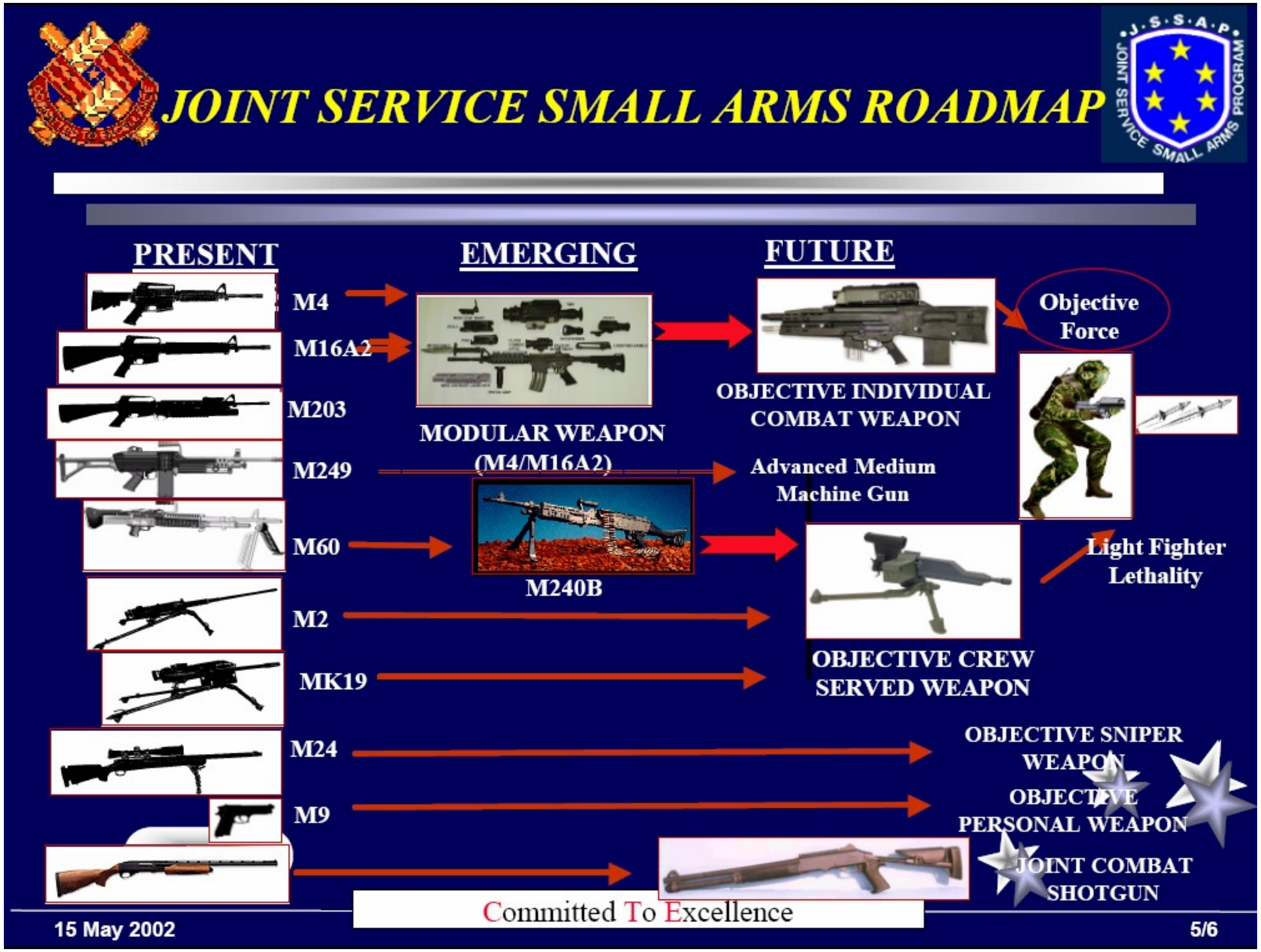
  - Flechettes, Caseless Ammunition – 1980's (Advanced Combat Rifle)
    Started as caseless ammo experiment. Redirected by CG change to 100% increase in pH over M16A2. Forced Mutation. DOA!
    $54M+ spent – nothing fielded!

System R&D Dysfunction (cont.)

1984 - USAIC first briefs "Small Arms Master Plan"

10 legacy weapons to be replaced by 3 "Objective" Weapons (OICW, OCSW, OPDW) (8)

24 years later.
Millions spent.
Nothing fielded!
Talk of next gen!



15 May 2002 JSSAP version pictured above

System R&D Dysfunction (cont.)

- Shift to "Air Bursting/Counter Defilade" technology

  OICW Program – Unrealistic requirements and expectations (Semi-auto AB 20mm GL, FS/FCS, detachable 5.56mm KE module @ 14 pds!)

  Not supported by end user, SOF, industry

  $207M spent over 17+ years (1991-2008).

  Nothing fielded!

- **OCSW Program – Failed attempt to field AB 25mm crew-served weapon. Program "saves" through FCS and Light weight .50 caliber Machine Gun initiatives.**

  $170M+ spent over 13+ years (1994-2007).

  Nothing fielded!

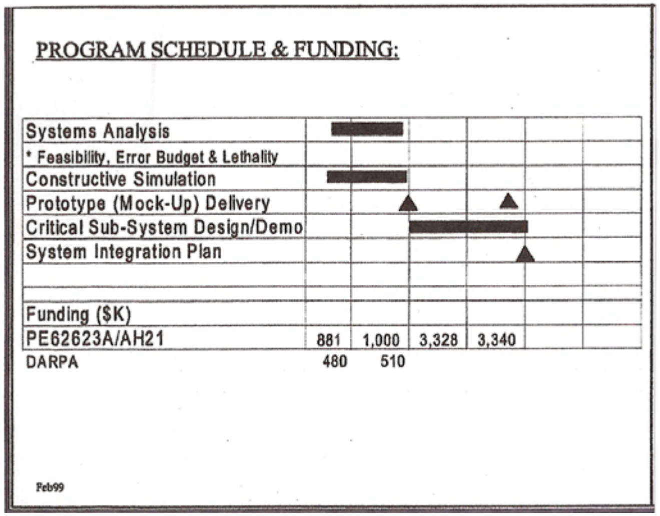
System R&D Dysfunction (cont.)

12 June, 1987
Twentieth Century Fox Film Corporation releases "*Predator*" with wrist-mounted KE system and shoulder-mounted "plasma caster"

$18M spent!
31M rentals fielded!

System R&D Dysfunction 2000-2001

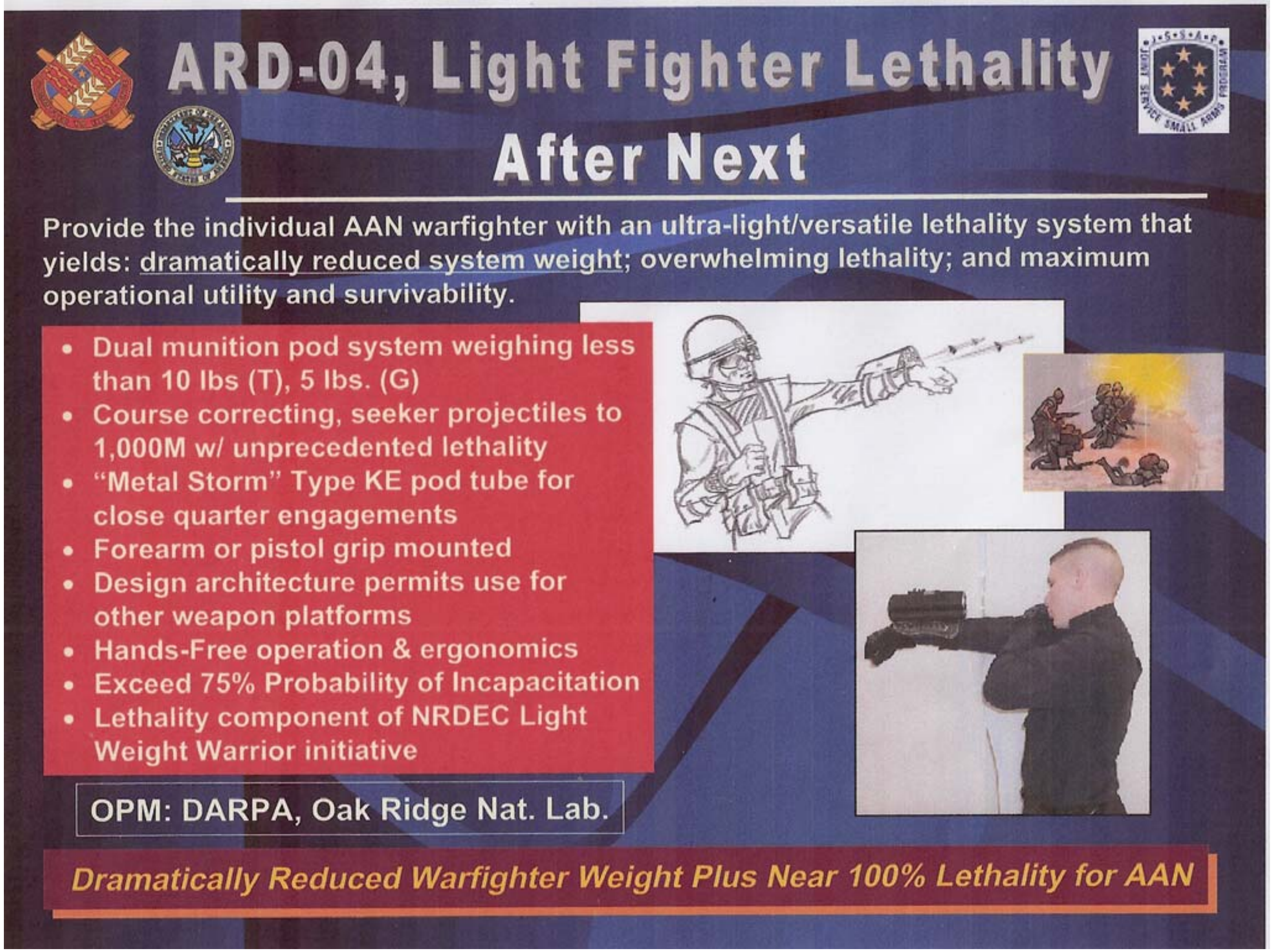
JSSAP "Autonomous Seeker Projectile" (9)



PROGRAM SCHEDULE & FUNDING:

Systems Analysis					
* Feasibility, Error Budget & Lethality					
Constructive Simulation					
Prototype (Mock-Up) Delivery					
Critical Sub-System Design/Demo					
System Integration Plan					
Funding ($K)					
PE62623A/AH21	881	1,000	3,328	3,340	
DARPA	480	510			

Feb99



- Unrealistic unobtainable science fiction based requirements.

- $8.6M actually planned for FY00-03 spending!

System R&D Dysfunction 2002-2004

- XM8 Effort – 2002-2005 *Good attempt at change!*

> Sole-source manipulation of OICW contract.
> Project forced on the user proponent.
> Weapon highly favored by the war fighters.
> Abandoned due to political pressure.

$50M spent. Nothing fielded!

- Multiple Parallel US DoD Efforts since 2003

> ECR, PMOD, FCR, SCAR, XM8, CSC (HK416)
> 95% compatible requirements
> No joint cooperation

$M's spent. Only HK416 fielded! (no USG R&D $ spent)

System Dysfunction 2005-Present

- **JSSAP LSAT Program**

- Plastic cased ammunition and links. ***Doable if durable!***

- Caseless Ammunition – same ammunition and chamber sealing challenges/barriers as encountered during 20+ year G11 and ACR Programs. ***High risk! Little payoff possible over plastic cased weight savings!***

Transition to PM-SW @ 2012

FUE @ 2019

Can our troops afford to "hope" for an unlikely technological breakthrough? (again!)

System Dysfunction *Today!*

- **In 2008 a representative from the advance technology directorate of a major US military service at a public event was quoted as having said:**

"XXX is looking for "tunable weapons," which can adjust from nonlethal to something more powerful. Like the Star Wars phasers of science fiction, such a weapon could presumably go from "Stun" to "Kill." [16]

A statement like this is simply detachment from reality!

"Gun Shy" Industry

"We have a broken process.
When you don't have a requirement
and acquisition process with
a shared vision,
you are not going to get anything,
and you are going to waste a lot of money"

COL Robert Carpenter
Former Crew-Served Weapons PM
PM-Soldier Weapons

False Start 1

- March 2005 – “OICW Increment I Family of Weapons” solicitation released to industry.
  - Closing date is November 2005
  - Intended to replace M4, M16, M249 and select M9’s
  - Full Rate Production Options of 134,500 weapons
  - Family of Weapons “commonality” Concept flawed – “games” LMG requirement at the cost of performance

  8 vendors respond they can meet/exceed specs

- October 2005 - DoD IG suspends OICW Increment I RFP due to lack of required program documentation and appropriate ACAT (Acquisition Category), weak OICW ORD. [10] ***ARDEC cancels RFP!***

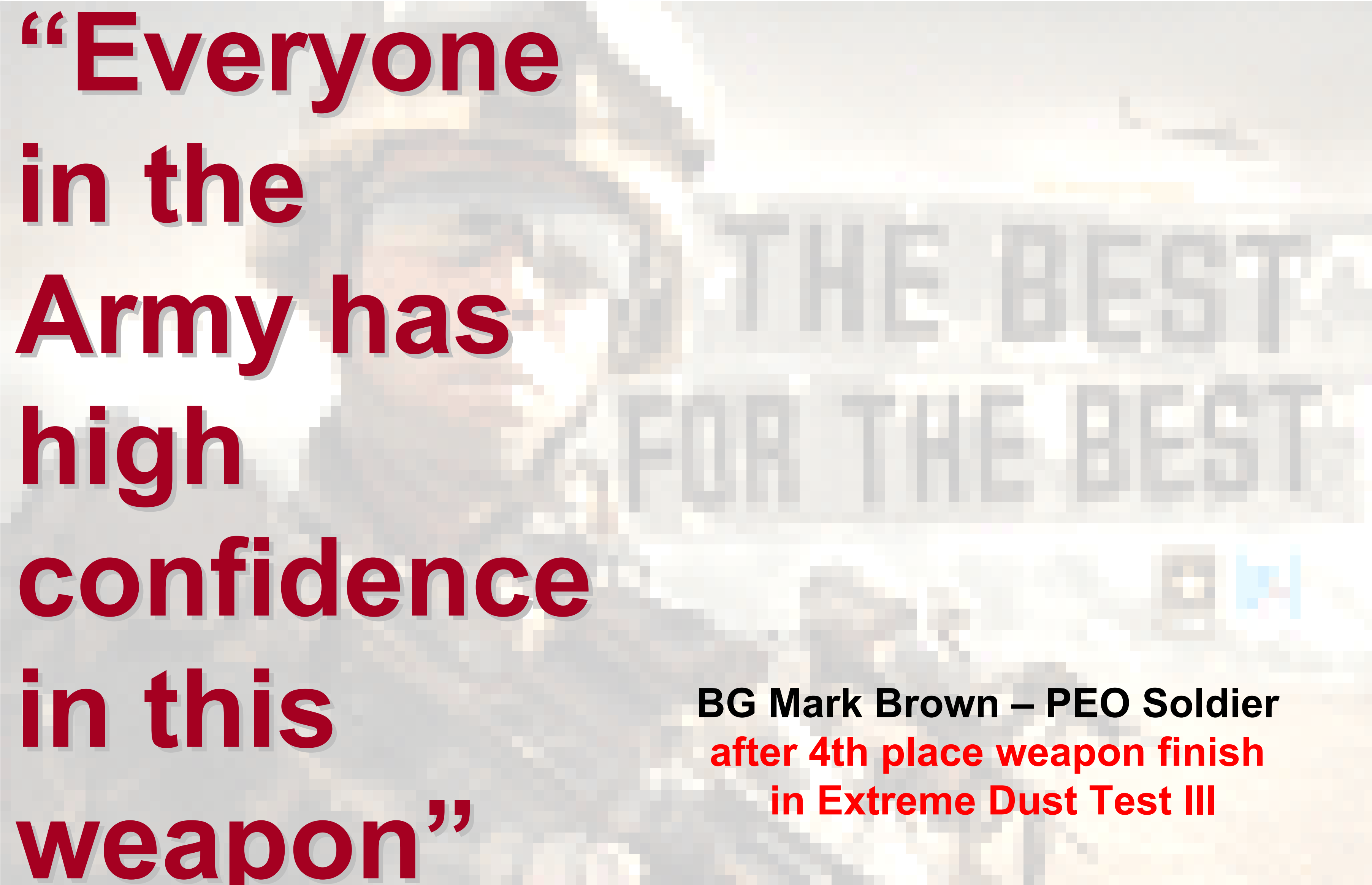
False Start 2 - *4 months later!*

- **Feb. 2006 – "Non-developmental Carbine" solicitation W52H09-06-R-0195 released to industry**
  - **193,400 carbines worth approximately $295M**
  - ***Done to force down rising cost of US standard!***

- **27 April, 2006 – *RFP Cancelled by ASA(ALT)!***

- **Nov. 2006 – IG investigation - "Prematurely released", "bad business practice", "wasted procurement resources", "engages industry for response to a solicitation then cancels the competition", "second carbine solicitation that the Army cancelled within one year". *Industry is understandably gun shy!***

Army's own data supports end user claims



“Everyone in the Army has high confidence in this weapon”

BG Mark Brown – PEO Soldier

after 4th place weapon finish in Extreme Dust Test III

Proven Last – APG Dust Tests

- 3 "Extreme Dust Tests" conducted by ATEC/APG.

- Test 1 – January 2007
  "Baseline Reliability and Dust Assessment"
  - 9,836 stoppages in 60,000 rounds. (page 3-16)
  1 stoppage every 6.1 rounds.

- Test 2 – June 2007 –
  "Extreme Dust Test II" - Changes in Lubrication (increased)
  678 stoppages in 60,000 rounds
  1 stoppage every 89 rounds.* (23) (*89 rd figure in contention)

- Test 3 – November 2007 – "Extreme Dust Test" (11) (12)
  Included 3 modern op rod carbines as per Congress
  XM8 – 1 stoppage every 472 rounds.
  SCAR L – 1 stoppage every 266 rounds.
  HK416 – 1 stoppage every 258 rounds.
  1 stoppage every 68 rounds.**

3 test average less than two full magazines (54.4 rounds)!

Proven Last – APG Dust Tests (cont.)

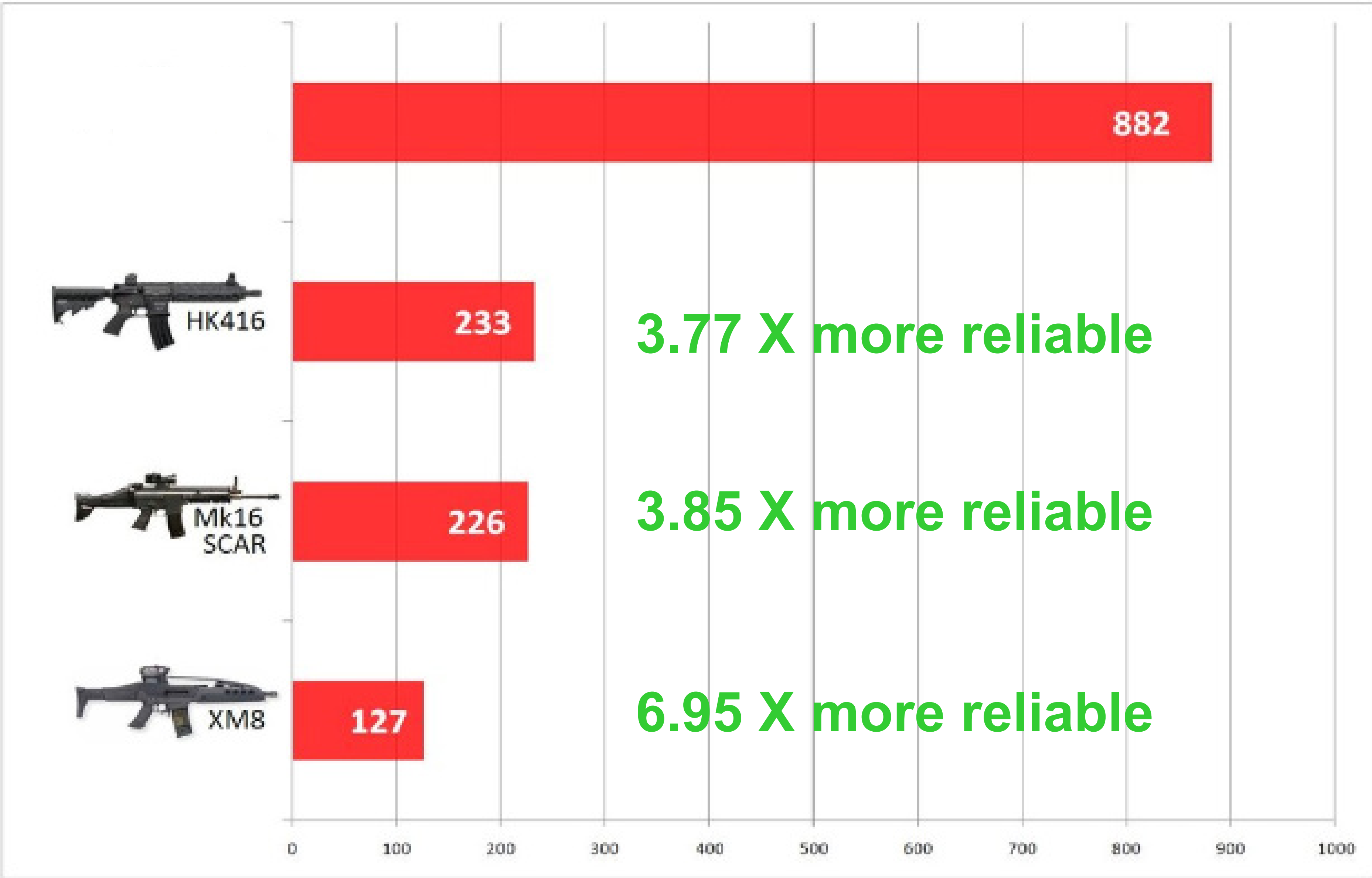
****The US Standard had 296 more Class I and II stoppages than all 3 op rod guns combined.**

Army's response: "These tests were conducted in extreme conditions that did not address reliability in typical operational conditions." (13)

Ask those soldiers in the Army-sponsored CNAC Soldier survey who had stoppages in a firefight if they agree!

STOPPAGES IN 60,000 ROUNDS FIRED PER SYSTEM

ATEC EXTREME DUST TEST III - 2007



System Answer

- System Offers to look into:
  - Hammer Forged Barrels
    - >Already used in 3 op rod guns tested!
  - Improved Magazines
    - >Already used in 3 op rod guns tested!
    - >NSN 1005-01-520-5992 in the system since 2004!

- *But we already knew this in 1990!*
  - USAMC "Independent Assessment of the 5.56mm XXX" – June 1990
    - >Barrels last < 10K rd. service life (7K)
    - >298 of 538 failure to feed stoppages caused by the magazine.

System Dysfunction - Current

- **After:**
  - Troubling 2006 CNAC Soldier Survey
  - 3 Unsuccessful ATEC/APG Dust Tests (mirrors that from CNAC Soldier survey reports)
  - NLT $430M spent on so-called "Leap Ahead" programs with nothing fielded
  - Congressional involvement and media exposure
  - Limited plans for superior replacements to the "Big 8"

- **The Army:**
  - "Pure fleets" the US Standard (< range, accuracy, E, pH)
  - Issues multiple, million dollar delivery orders for more carbines (up to $525M), rifles, SAW's, pistols, AGL's, M203 grenade launchers ***without conducting comparative tests!***

- **And states: "We are in a strategic pause."**

Continues New Purchases

Army Times 2/19/07

WEAPONS AND TRACKED VEHICLES	
1,037 **M1 Abrams** tank engines	$185.9 million
69,678 **M4 carbines**	$97.6 million
Nine **M1A2 SEP tanks**	$52.9 million
8,382 **M249 squad automatic weapons**	$35 million
2,308 **M240 machine guns**	$37 million
970 **MK19 automatic grenade launchers**	$21 million
694 **XM110 semi-automatic sniper rifles**	$10 million
5,328 **modular shotgun** systems	$7 million

69,678 M4 carbines

- **6 April, 2007 – M4 Carbines - $50.8M**
  up to $375M planned + $150M for mods
- **3 August, 2007 – M249 SAW's – up to 40,065 weapons**
- **26 December, 2007 – M16A3/A4 Rifles - $49.6M (between two vendors) 3rd vendor bid $117 less per rifle ($20M over life of contract) – *NO DEAL! You never made an M16A4!***
- **Additional MK19's and M2HB's ordered in 2007**
  Production maxed out!
- **2008 contract award for 25,403 M9 pistols**

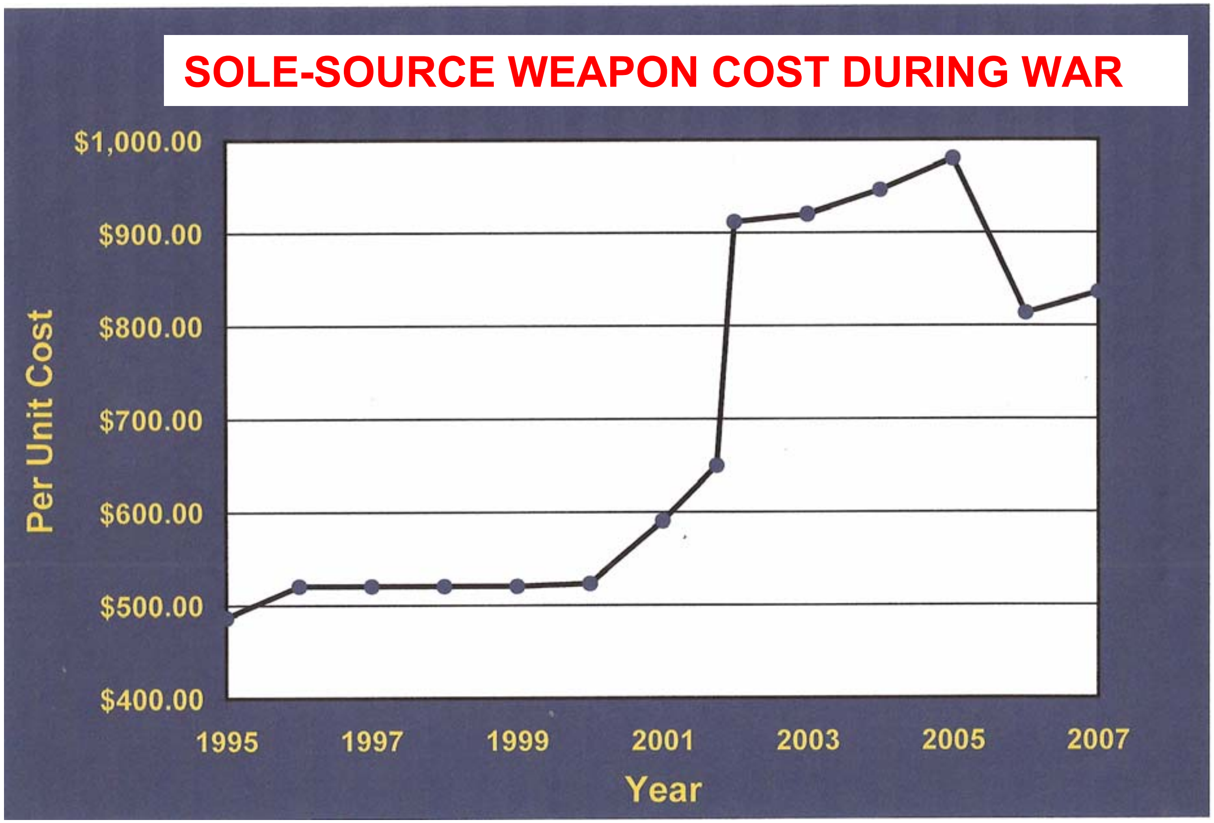
The Cost Argument (Tail wagging the Dog!)

System Dysfunction 2007

- GAO Report – 2007
  - 72 DoD weapon programs $295B over budget and 21 months on average behind schedule. [20]
  - R&D costs are 40% over budget
  - $355B is planned for new weapon systems

- For the $430M spent on "Leap Ahead" Small Arms efforts since 1980 **we could have purchased:**
  - 238,908 SCAR-L's @ $1800 each
  - 330,756 new op rod rifles @ $1300 each
  - 430,000 new op rod Upper Receivers @ $1000 each

Sole Source Cost to the Tax Payer



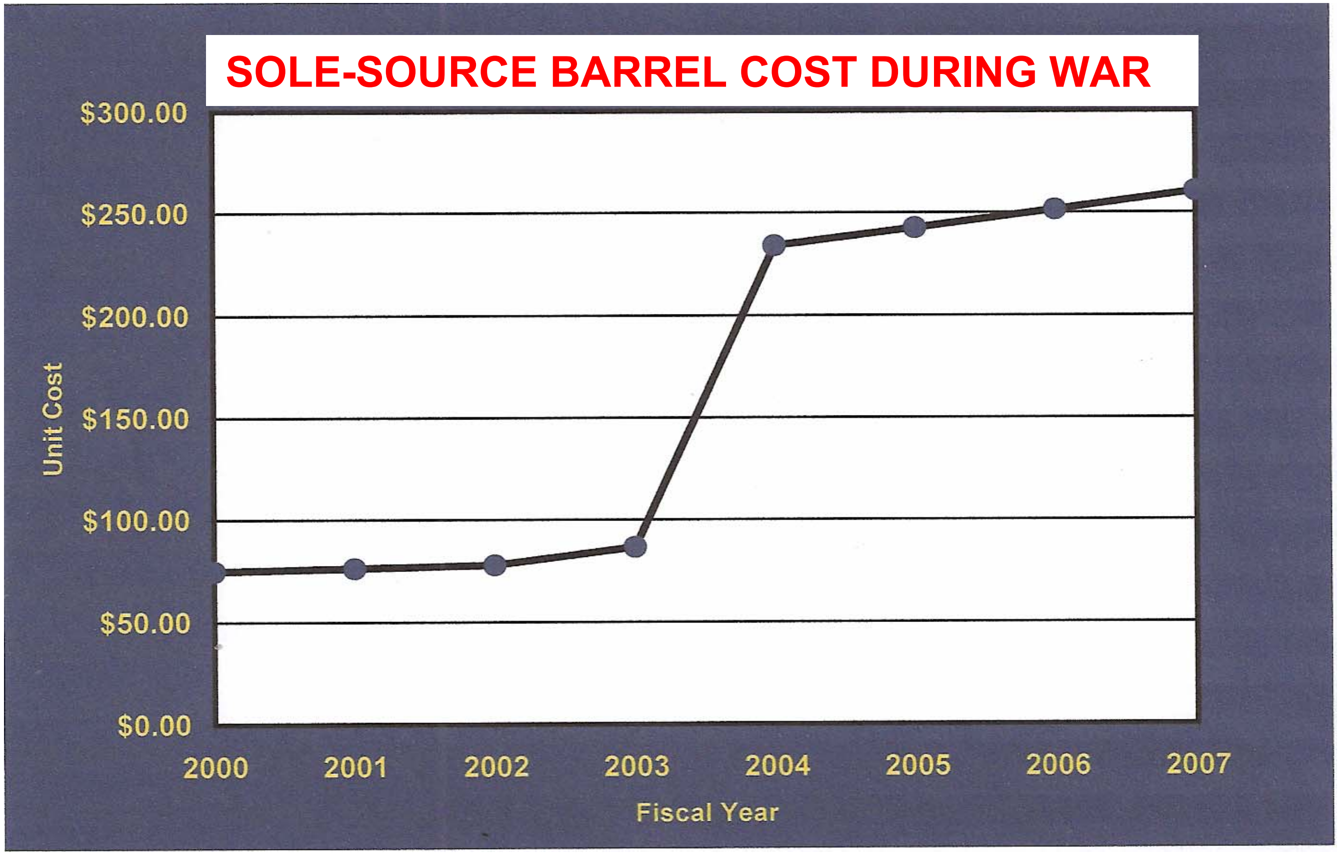
- **40% increase in purchase price ($523.84 in 2001, $980.00 in 2005, $1169.48 in 2007)** (15) (22)

  - During war time

  - At increased order quantities (economies of scale?)

- **2.5 X the purchase price of the longer US Standard**

Sole Source Cost to the Tax Payer (cont.)



- **248% increase in purchase price ($74.91 in 2000 - $260.57 in 2007)** [15]
  - **At increased order quantities (economies of scale?)**
  - **During war time**
- **140% higher purchase price compared to that of longer US Standard ($240 vs. $100)**
- **Proven superior COTS alternatives (3-4X service life) available for =/< purchase price**

Purchase Cost vs. Life Cycle Cost - Weapon

Item	Unit Cost ($)	÷ Service Life (1) (# rounds) =	Cost (cents) per rd. fired	X 20,000 rd. Life Cycle Cost =	X Division Cost (18K) =
US Standard Weapon	**$1,000** (Qty K's)	**6,000** (2)	**17**	**3,400**	**$61,200,000**
Superior COTS Weapon	**$1,425** (Q 1)	**24,000** (3)	**.06**	**1,200**	**$21,600,000**
Superior USG Weapon	**$1,800** (Qty K's)	**35,000** (3)	**.05**	**1,000**	**$18,000,000**

- **Superior Weapons 3.4X less costly to maintain over projected 20K round service life.**
- **Superior weapons offer 67% lower life cycle costs.**

- **Costs do not include: Armorers repair time/cost/training, piece parts, replacement effort for user, logistical burden, serial number accountability, operator safety, confidence, survivability.**

(1) # rounds that can be fired before parts replacement. (2) US MIL SPEC (3) USG test data

Q = Quantity K = Thousands 1 = one

Purchase Cost vs. Life Cycle Cost - Barrels

Item	Unit Cost ($)	÷ Service Life [1] (# rounds) =	Cost (cents) per rd. fired	X 20,000 rd. Life Cycle Cost =	X Division Cost (18K) =
US Standard Weapon	$243 (Qty K's)	6,000 [2]	.04	800	$14,400,000
Superior COTS Weapon	$475 (Q 1)	24,000 [3]	.02	400	$8,000,000
Superior US Weapon	$300 (Qty K's)	35,000 [3]	.009	180	$3,600,000

- **Weapons using superior barrels are 1.8 - 4X less costly to maintain over 20K rounds.**
- **Superior Barrels offer 4 - 5.8X increased service life and 45 - 75% lower life cycle costs.**
- **Costs do not include: Armorers exchange time/cost/training, piece parts, test fire, replacement effort for user, logistical burden, serial number accountability, operator safety (OTB), confidence, survivability.**

[1] # rounds that can be fired before replacement. [2] US MIL SPEC [3] USG test data

Q = Quantity K = Thousands 1 = one

Business Case Analysis

- 2 August, 2005 an Army (PM-SW) Business Case Analysis determined that **the US could save $1.2B over the life of the system** by replacing the legacy carbine, rifle, **SAW (# 1 urgent USAIC replacement priority at that time)** and select handguns with a "modular family of weapons."

- The Army projected $12M (2% of the cost of procurement) would be spent to conduct the competition.

No further action has been taken to date!

Better Available Off-the-Shelf

At least one manufacturer has stated publicly they would offer their superior combat proven COTS op rod weapon far exceeding the MIL SPEC's of the current US issue weapon at prices matching the US current contract price and can begin producing and delivering no less than 4,000 weapons per month immediately after receipt of order…..

And the US is not interested?!?!

Every Problem has a Solution

1 – End User Absence

Small Arms Decisions are being made “too far from the field” and end user by:

- GO’s, PEO’s, PM’s, Proponents, Retirees *that are not fighting with small arms!*

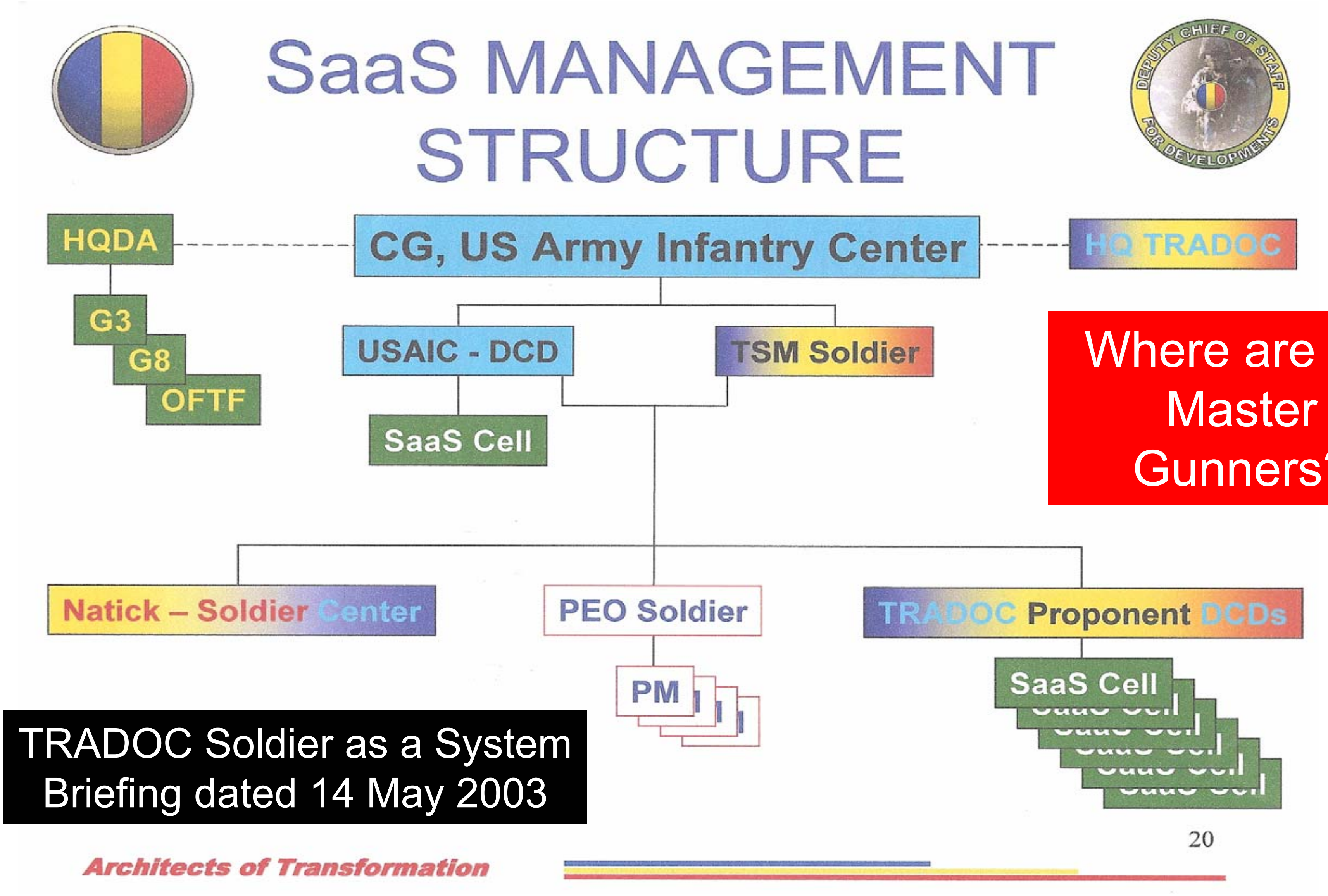
- The system MUST support the specific needs of the end user, *NOT vice versa!*

- The current Executive Agent for Small Arms repeatedly fails or is too slow to react.

ANSWER: *Adopt Select US Unit SOP!*

Where is the End User?

The guy on the ground at this very moment carrying the weapon!



Where are the Master Gunners?

TRADOC Soldier as a System Briefing dated 14 May 2003

2 – Unrealistic Requirements

Stop chasing "Star Wars" (SAMP, OFW)

- What does US select/SOF purchase, field? **Combine efforts.**
- Efforts must focus on **obtainable** goals.
- "Leap ahead" efforts divert focus and funds from end user requirements.

ANSWER: Look to the future
<u>but buy what works, and now</u>.

3 – Changes in Direction

Too many Changes, False Starts, Revisions

- "User Small Arms Advisory Panel" (USAAP)

- Directs system on:
    - > Incremental Fielding Focus (1-3 years)
    - > Future Programs (3-5 years)
    - > R&D (5-10 years)

Answer: Form the USAAP now!

Answerable to Congress and SECDEF only!

USAAP
(User Small Arms Advisory Panel)

- **User, US select unit Representation.**
- **Proven incremental fielding representation.**
- **Self-vetting. No PM's, PEO's, AO's, other.**
- **Answerable only to Congress, SECDEF**
- **Directs, approves actions of system on:**
  - **Current product performance**
  - **New item testing**
  - **Contract awards and extensions**
  - **R&D program funding (current and new)**

The system truly working for the end user!

4 – Outdated MIL SPECS

US Small Arms Performance Specs (PS's) are outdated and force sole-source procurement of outdated materials

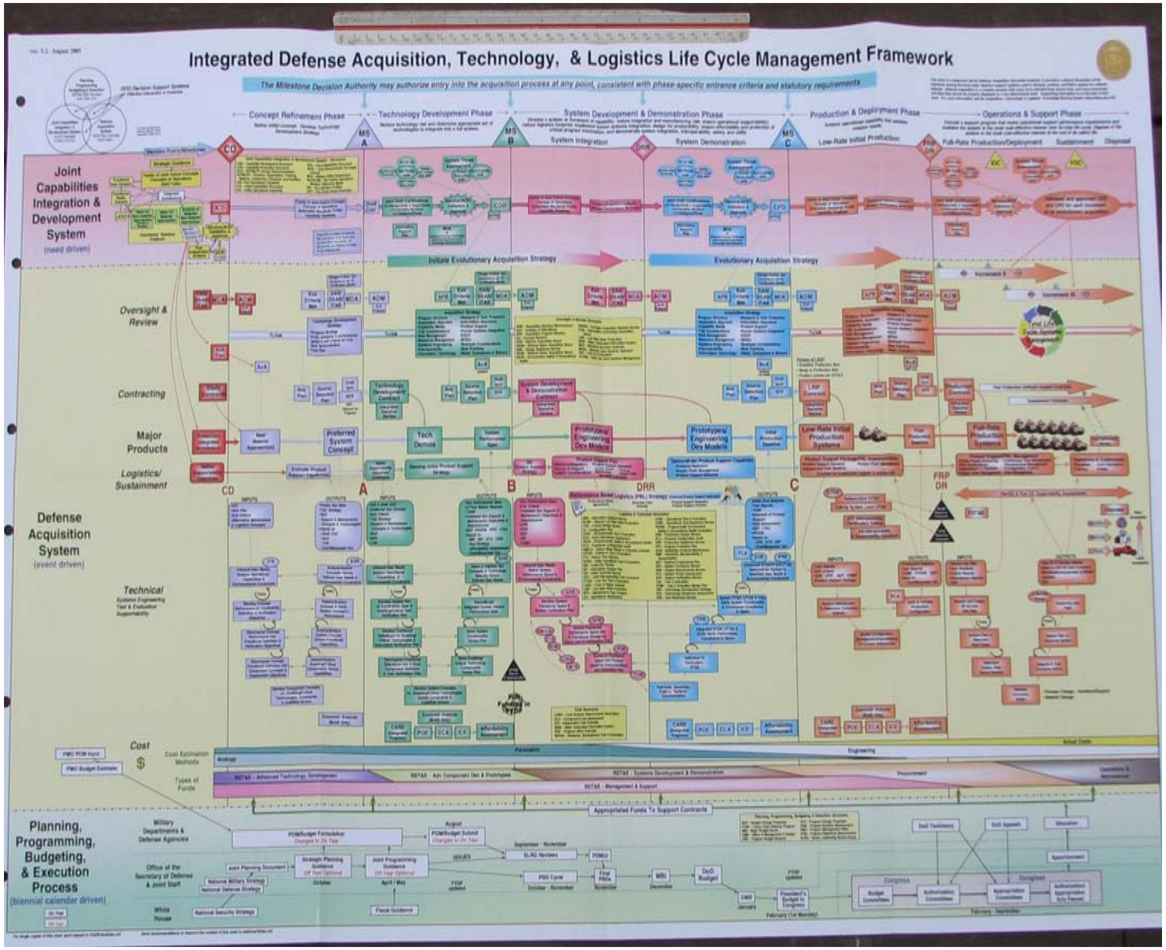
- **Must be revised every 3 years and for each new contract based upon current state-of-the-art performance**
- **New "best of breed" must be found and evaluated regularly**
- **New PS's must be written/approved by USAAP *before recompetes!***

ANSWER: Update PS's often

5 – Remove JCID's for Small Arms

The JCID's process is simply unworkable for incremental and timely small arms fielding

- Delays fielding
- Hampers urgent responses
- Drives up costs
- Creates programs versus solutions!



ANSWER: Dump JCID's for Small Arms

6 – System Support

The Small Arms Support System (Development, Acquisition, Contracts, Logistics) must support the direction/decisions of the end user through the USAAP.

- **Utilize the talents, facilities already in the system**
- **Stop chasing the Logistical Tail!**
- **The system works for the end user.**
- **More security for all by greater turnover of new systems and system success**

ANSWER: User/USAAP directs Support System

7 – R&D Black Hole

Studies, Simulation and Modeling should not replace regular incremental fielding

- **Find and field the "90% solution", *and regularly***
- **Incremental fielding provides the greatest return on investment**
- ***Endless Multi-year Programs do not kill bad guys! Nor do they protect the friendlies!***

ANSWER: User/USAAP approves all new small arms R&D programs

8 – Promotion Suicide

Remove the "Yes Man" promotion rule from small arms efforts

- Few AO's, PM's have small arms experience let alone expertise

- Act on user/USAAP direction, not that of superiors inexperienced with small arms who control a subordinates future and push bad small arms decisions

Then PM's will become true "Action Officers"

ANSWER: Make the system answerable to the User/USAAP

9 – Joint Efforts

Very few combined efforts today in US Small Arms development yet the basic use of small arms is the same

- **Combine Requirements, Interagency Participation and Support**
- **Generate Realistic User/USAAP Based Requirements for Near Term Fielding**
- **User/USAAP Selection *a must!***

ANSWER: Joint efforts will bring success if User requirements are supported by the system

10 – Contract Limits

No Small Arms Contract should exceed 6 years

Regular contract awards will:

- **Generate more competition, innovation, willingness to participate by non-traditional vendors**
- **Keep unit prices low and quality high**
- **Will leverage emerging technology more often**
- **Will respond to ever changing warfare**

ANSWER: Restrict contracts to maximum of 6 years for same item from same vendor

11 – Don't Buy TDP's

Most small arms production TDP's are usually outdated before contract end and often even before they are received

- Especially in a "stimulated" small arms competitive environment as described above

ANSWER: Look for new superior products, not yesterdays product drawings

12 – Avoid Distractions

System developed alternatives (NSAC/NSATC) seldom bring value to the war fighter

- Costly duplication of effort. A distraction.
- Must "pay to play" ($1000 + 10%)
- Would Messrs. Hall, Maxim, Browning, Lewis, Thompson, Garand, Stoner, etc. have paid to participate?

ANSWER: Focus the existing support system on rapidly answering the needs of the End User

13 – Limited Combat Evals

Use Limited Combat Evaluations by actual end users to assess the effectiveness of proven systems and capabilities

- **Apply Select US Unit SOP**
- **Field at Company or BN level**
- **After mandatory safety testing**
- **After pre-deployment, New Equipment Training by SME's (SOF, contractor, etc.)**

ANSWER: Let the Users and their Commanders decide what works best on the battlefield and against the enemy

14 – "Up gun" Calibers

Reevaluate US self-imposed voluntary restrictions on Ammunition and Projectile limitations for Conventional US Forces

- Consider medium caliber for America's rifle/carbine and LMG
- Look at non-NATO calibers
- Look at Non-compliant "Land of Warfare" approved projectiles (BTB, JSP, HP, etc.)
- Follow Select US Unit SOP, successes
- Develop an optimum weapon/ammo "system"

ANSWER: Adopt the very best in ammunition and projectile technology

15 # - Small Arms Funding

With greater success in small arms fielding for the war fighter the system will:

- Be rewarded with additional funding for future procurements and small arms efforts
- Stop being maligned and criticized
- Attract the best and brightest
- Better guarantee job and facility security
- Experience unparalleled support from Industry, Congress and the American people

ANSWER: Field it and they will come.

3-year Incremental Fielding Cycle

On a three-year cycle USAAP:

- Reviews (every 3rd year)
  - USG and COTS System Performance and Specifications, PIP's, Threats, etc.
  - R&D Programs (current, new)
- Tests (every 4th year)
  - Solicits Industry for and tests incrementally superior systems
- Contract Award (every 5th year) NTE 6 years

3-year Incremental Fielding Cycle (cont.)

- **Limited Combat Evaluations to prove out system capabilities**
- **First fielding to high-use, front line units**
- **Keeps opponents guessing on US small arms capabilities set while leveraging newly emerging COTS capabilities**
- **Contractor-provided Logistical Support should be leveraged as in the UK and Germany**

You may be part of the problem

- **If you use words and phrases like:**

- "Backwards Compatibility"

- "Too expensive to change"

- "Meets Specs"

- "Is good enough"

- "Tactical Patience" - excuse for more of the same

You may be part of the problem (cont.)

- **If you:**

- Cherish words like “Logistical Tail”, “Revolutionary” and “Leap Ahead”

- Respond to urgent user requirements by looking at a calendar (PM) and not your watch (End User)

- State conventional and SOF small arms performance needs are not the same

You may be part of the problem (cont.)

• **If you:**

- State that those who question the poor performance of current equipment undermine the confidence of the war fighter

- Do not embrace and seek out regular and direct end user involvement in ordnance selection

- Have not read the book "Misfire" and "The Black Rifle"

"The Soldier in the field is our number one priority"

Secretary of the Army Pete Geren
From US Army News Release dated 17 December, 2007
after forth place finish of US Standard
in APG Extreme Dust Test III

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Time for a Change

US "Incremental" Small Arms Fielding – Failures and Solutions

Part I - Small Arms

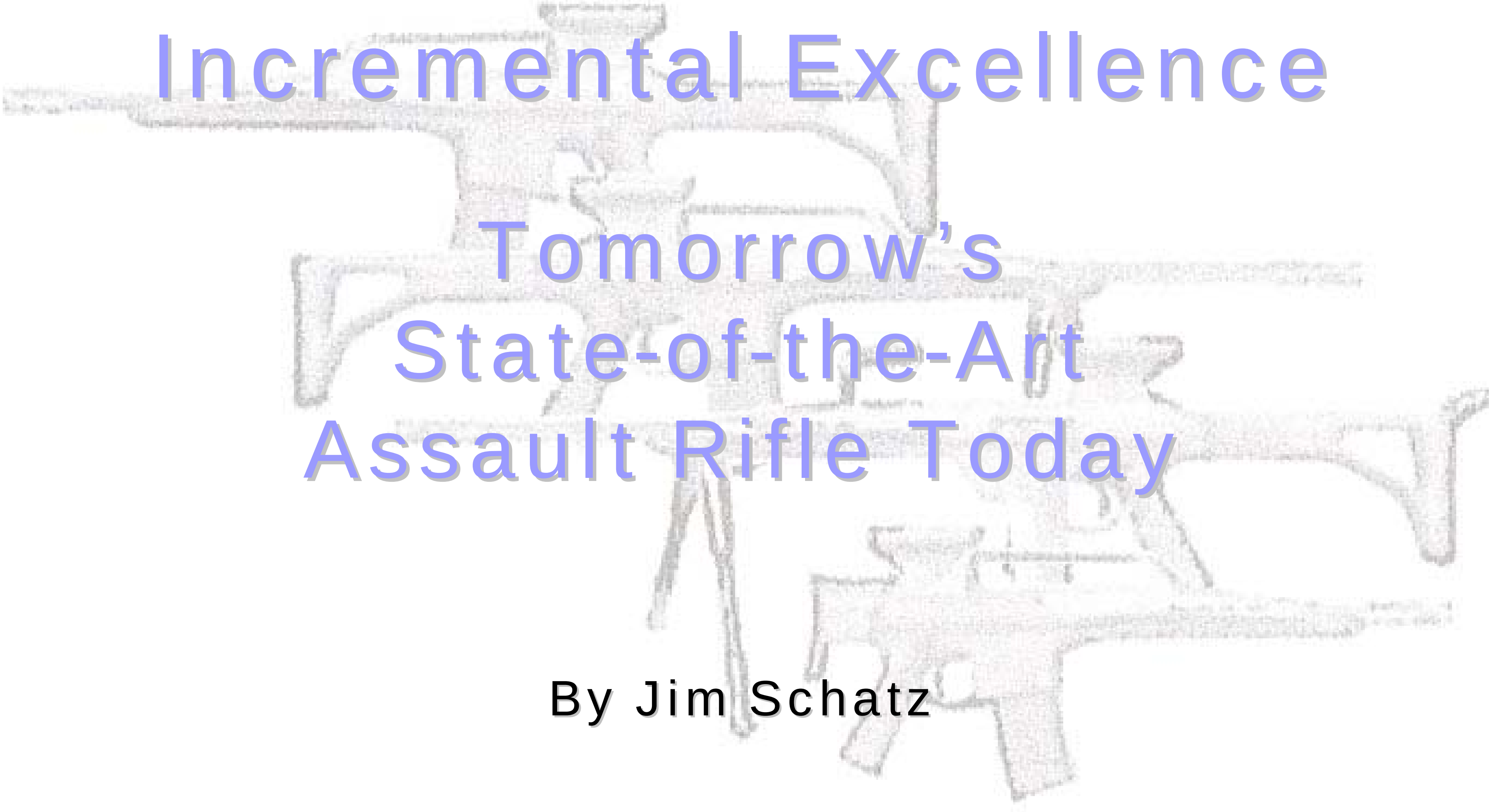
by Jim Schatz

052008

Incremental Excellence

Tomorrow's State-of-the-Art Assault Rifle Today

By Jim Schatz



Introduction

- Follow-on to the 2008 NDIA Paper
  "Incremental Small Arms Fielding – Failures and Solutions"
  May 2008 - Dallas, TX

- Explore the "What If" Possibilities for the War Fighter of:
  - Considering and cataloging superior incremental performance & features scattered throughout the world's leading assault rifles
  - Exploiting the 10 most important proven incremental enhancements available in today's modern assault rifles
  - Conventional vs. Bullpup configuration
  - Quantifying "Package Performance" of the ultimate incrementally superior assault rifle/carbine, or family of weapons, for near term fielding (< 3 years)
  - Primary aspects covered – others (ruggedness, safety, environmental extremes) "a given"

** All data, claims supported by reference materials*

Qualifications – Jim Schatz

- **User: 11B – 82nd Airborne Division**
- **Trainer: US Army Marksmanship Unit**
- **Provider: 22+ years to the US Government, war fighter**
  - ***Logistical Support***
  - ***Contracts***
  - ***Fielding***
- ***Involved as US Contractor Developer: HK416/417, M1014, USP/JCP, MP5/10, MSG90, ACR/G11,others***
- **Student: Of small arms since age ten**
- **Supporter: Of the end user**

NO direct affiliation with firearms or ammo makers.

NOT the “lone voice” on this issue! One of many.

Goal

To find, test and field the best small arms and ammunition available to the American war fighter today and always!

Small Arms "Disconnect"

- Night Fighting Equipment
- Helmets and suspension
- Load bearing equipment
- Uniforms, boots, gloves
- Body Armor
- Eye, Ear Protection
- Rations, water carriers
- Communications gear
- Cold/wet weather gear
- First Aid pack, gas masks
- Anti-tank weapons

20 years Ago

2008

Weapons designed in the 1960's, *or earlier!*

The Cause – Our Aged Fleet

The "Big 8" – Primary US Military Small Arms						
Weapon	**Year First Fielded** [1]	**Age (Years)**	**Manufacturer**	**Modern Design Available**	**Replaced by OFW candidate**	**Comments**
M9 Pistol 9x19mm	1985 (Army)	23	Beretta USA	Beretta Brigadier, PX4, others	No	Numerous modern alternatives abound, to include PDW calibers
M4 Carbine 5.56x45mm	1994 (Army adoption)	14	Colt Defense	Colt M5, XM8, HK416, SCAR L, others	No	Modern Op Rod designs
M16A1 Rifle 5.56x45mm	1967 (Type classified by Army)	41 [2]	FNMI, Colt Defense	FN SCAR, F2000 Colt M5, HK416, XM8	No	Modern Op Rod and/or bull pup designs
M203 Grenade Launcher 40x46mm	1969	39	Various	US XM320	No	3+ years since COTS contract award
M249 Squad Automatic Weapon 5.56x45mm	1982	26	FNMI	FN MK46	No	MK46 fielded with USSOCOM
M240B Medium Machine Gun 7.62x51mm	1976 (Army)	32	FNMI	FN MK48, Vector SS77, US Ord. M60E4, Barrett LW240, HK121	No	MK48 fielded with USSOCOM
MK19 MOD 3 Automatic Grenade Launcher 40x53mm	1988 (Army)	20	GD	GD MK47, HK GMG	No	MK47 and GMG fielded with USSOCOM, OGA's
M2HB Heavy Machine Gun .50 BMG	1923	85	GD	GD M2E2, GD XM312	No	
	Average:	**35**	**All eight weapons above**			
	Average:	**28**	**Without M2HB**			
	Average:	**26**	**Without M2HB and M203**			
	Average:	**23**	**Without M2HB, M203, M16**			

"OFW" - Objective Family of Weapons from "Small Arms Master Plan" (SAMP) first briefed in 1984 by the USAIC.

[1] All initial fielding dates taken from "Jane's Infantry Weapons, 2007/2008 edition. [2] America's longest serving service rifle.

The “Big 8” – Showing their Age

Average: 35 All eight weapons

Average: 28 Without M2HB

Average: 26 Without M2HB and M203

Average: 23 Without M2HB, M203, M16

- **Trickle Down” effect. What the system buys often ends up in:**
  - **All branches of our military**
  - **US State Department/Embassy security**
  - **OGA’s (federal law enforcement, DOE, NRC, FBP, other)**
  - **State and Local law enforcement**
  - **Foreign Military Sales (FMS)**

Definitions – Part I

- “Incremental” Improvements
  - The “90% solution”
  - Available as COTS/NDI, modified COTS

  - Significant advantages for ***the end user!***
    > **Reliability**: 7X that of US standard
    > **Service Life**: 3 – 4X that of US standard
    > **Improved Accuracy**: 30-50% increase
    > **Safety**: OTB (0 vs. 6 sec. drain time), Increased (60%+) Cook Off (210-240 vs. 120-150 rounds), SBFA (catch live projectiles during blank firing)
    > **Weight Reduction**: up to 20% (system)

Definitions – Part I

- "**Incremental**" **Improvements** (cont.)

- Significant advantages for the end user

> **Modularity, User Configurable, Controls: (SCAR, XM8, ACR/Masada)**

> **Parts Commonality: 82% between 5.56mm, 6.8mm and 7.62mm (SCAR)**

> **Reduced Maintenance (user, maintainer): 72% less cleaning time (any Op Rod system)**

> **Reduced Procurement Costs: (complete weapons, barrels, piece parts)**

> **Reduced Life Cycle Costs: 45-75%**

Incremental vs. "Leap Ahead"

- Ground combatants still kill the enemy with KE mechanisms (bullets, fragments) that must be:
  - Accurately aimed and delivered to the target by skilled operators (even AB munitions and LRF's)
  - From belt buckle distance to MER
  - Same for all – Conventional, SOF, enemy

- The last "leap ahead" advancement in small arms – 14 century "Hand Cannon" (first KE firearm)

- The last substantial "incremental" advancement in US-issue rifles/carbines was America's first Assault Rifle the AR-15/M16 ***more than four decades ago!***

- The US "Big 8" small arms are 35 years old on average. 23 years without the oldest 3. In comparison, Germany has replaced 9 of 10 small arms since 1994 with incrementally superior small arms now available as COTS items.

Threat Successes

Russian AN-94
“Shifted Pulse”
Assault Rifle
5.45x39mm
pH doubled @ 1800 rpm ROF
In limited production and fielding since 2001. Being developed in 7.62x39mm.

Chinese QBZ-95/97 Family of Weapons - 5.8x42mm Superior cartridge/bull pup ammunition performance. Heavy penetrator (lead penetrator “pusher”) coming. First fielded in 1998.

The US has nothing that competes with these weapon capabilities!

Russian SR-1 Gyurza Armor Piercing Semi-automatic Pistol 9x21mm SP-10, SP11, SP-12 Adopted in 2003. Penetrates 2.8mm Titanium and 30 layers Kevlar at 100 meters.

Quad Chart Explanation
Performance Category

Description of Performance Category	**Example:** **Legacy System Performance**
Example: **Incrementally superior COTS/NDI System Performance**	**The Value to the War Fighter**

Conventional Configuration

Comparison Table 10 current/modern Conventional-configuration Carbine-length Assault Rifles											
Weapon	**HK33K**	**Beretta ARX 160**	**G36K**	**Daewoo K1A**	**SIG 551**	**AK102**	**XM8 BC**	**M4**	**HK416**	**SCAR L**	**Averages**
Overall Length[1] mm/(in.)	**865 (34.1)**	**900 (35.4)**	**860 (33.9)**	**838 (33.0)**	**833 (32.8)**	**824 (32.4)**	**838 (33.0)**	**838 (33.0)**	**900 (35.4)**	**889 (35.0)**	**859 (33.8)**
Barrel Length mm/(in.)	**322 (12.7)**	**305 (12.0)**	**320 (12.6)**	**263 (10.4)**	**363 (14.3)**	**314 (12.4)**	**318 (12.5)**	**368 (14.5)**	**368 (14.5)**	**355 (14.0)**	**330 (13.0)**
Muzzle Velocity mps/fps	**840 (2756)**	**838 (2750)**	**N/A**	**820 (2690)**	**N/A**	**850 (2789)**	**N/A**	**838 (2750)**	**N/A**	**826 (2710)**	**835 (2740)**
Key Features	**BB**	**OR** **ACH** **QCB** **ECH** **AE** **CC**	**OR, ACH, AFA**	**OR – K2 Carbine only**	**OR**	**OR**	**OR, ACH, AFA, ISM**	**ACH**	**OR, ACH, QCB option**	**OR, ECH**	**OR – 7-8/10**

[1] **Length provided is weapon in "fighting" configuration (buttstock fully extended, if applicable).**

Note: Threat Standard (7.62x39 mm AKM) – OL = 870/690 mm (34.3/27.2 in.) Bbl Length = 415 mm (16.34 in.) MV = 710 mps (2330 fps)

Note: OL on average is 529 mm (20.1 in.) longer than barrel length.

Key: **ACH** – Ambidextrous Charging Handle **AE** – Adjustable Ejection **AFA** – Ambidextrous Forward Assist **BB** - Blowback
CC - Caliber Conversion (by user) **ECH** – Exchangeable Charging Handle **FE** – Forward Ejection
ISM – Integrated Sight Module (reflex sight/lasers) **LAM** – Laser Aiming Module **OR** - Op Rod Gas System
QCB – Quick-change Barrel (w/o tools) **SM** – Sight Mount permanent to barrel

Bullpup Configuration

Comparison Table 10 current/modern Bullpup-configuration Carbine-length Assault Rifles											
Weapon	**FAMAS**	**AUG**	**F2000**	**QBZ-97**	**TAR-21**	**SAR-21**	**Vector CR-21**	**L85A2**	**A-91**	**Valmet M82**	**Averages**
Overall Length mm/(in.)	**757 (29.8)**	**805 (31.7)**	**694 (27.3)**	**760 (29.9)**	**720 (28.4)**	**805 (31.7)**	**760 (29.9)**	**780 (30.7)**	**660 (26.0)**	**710 (28.0)**	**745 (29.3)**
Barrel Length mm/(in.)	**488 (19.2)**	**508 (20.0)**	**400 (15.8)**	**520 (20.5)**	**460 (18.1)**	**508 (20.0)**	**460 (18.1)**	**518 (20.4)**	**400 (15.8)**	**420 (16.5)**	**468 (18.4)**
Muzzle Velocity mps/fps	**960 (3156)**	**940 (3084)**	**920 (3019)**	**930 (3051)**	**910 (2986)**	**N/A**	**980 (3215)**	**940 (3084)**	**N/A**	**N/A**	**940 (3084)**
Key Features	**BB**	**OR, QCB**	**OR, FE**	**OR, ACH**	**OR, AE, ECH, LAM SM**	**OR, ACH, LAM**	**OR**	**OR**	**OR, FE, ACH**	**OR**	**OR - 9/10 FE – 2/10**

Note: Threat Standard (7.62x39 mm AKM) - OL = 870/690 mm (34.3/27.2 in.) Bbl Length = 415 mm (16.34 in.) MV = 710 mps (2330 fps)

Note: Bullpup average OL is 125 mm (4.92 in.) shorter than the AKM (stock extended) and provides @ 230 mps (755 fps) > MV from a 52.3 mm (2.06 in.) longer barrel.

Note: OL on average is only 277(10.9) longer than barrel length.

Key: **ACH** – Ambidextrous Charging Handle **AE** – Adjustable Ejection **BB** - Blowback **ECH** – Exchangeable Charging Handle **FE** – Forward Ejection **ISM** – Integrated Sight Module (reflex sight/lasers) **LAM** – Laser Aiming Module **OR** - Op Rod Gas System **QCB** – Quick-change Barrel (w/o tools) **SM** – Sight Mount permanent to barrel

#1 – Reliability

Most important aspect of all combat equipment – all other aspects are reliant upon proper operation when needed.

Legacy System

- **MRBS**

- 1,130 rds (0106DT)

- **667 rds** (US MIL SPEC)

- **MRBF**

- **3,000 rds** (US MIL SPEC)

- **XM8** = 18,000 MRBS/F
  = 7X more reliable in 2007
Extreme Dust Tests
- **SCAR L** = 3.9X more reliable in 2007
Extreme Dust Tests
- **HK416** = 3.8X more reliable in 2007
Extreme Dust Tests
- **L85A2** = 25,200 MRBF

* **All with Operating Rod Gas Systems**

- **Increased end user survival**
- **Increased confidence**
- **Enhanced unit performance and mission success**

#2 – Safety

End user must be protected from catastrophic equipment failure under all conditions.

1. Cook off @ 180 rds.
2. Barrel failure @ 540 rds.
3. Blank firing safety
   – Tragic French Military shooting, June 2008
4. OTB – 6+ seconds

1. 180-210 rds. (SCAR L),
   > 240-270 rds. (HK416, XM8, G36)
2. > 900 rds. – (G36)
3. Safety Blank Firing Adapter catches 3+ live rounds
4. OTB capable (0-2 sec SCAR L, 0 sec HK416)

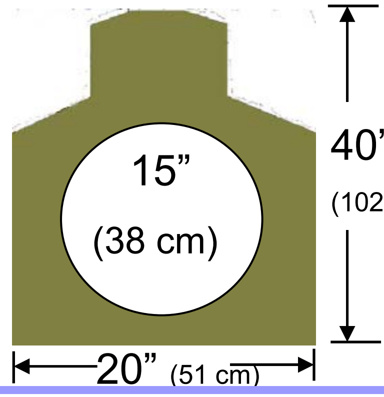
Enhanced user & bystander safety – +30% (cook off) +40% (barrel failure) 6X faster OTB

#3 – Probability of Hit
A – System Accuracy

A reliable, safe operating weapon must facilitate hit probability through inherent system accuracy (weapon, ammo, sight).

NTE 5" (127 mm) 10-shot group @ 100 y (91.4 m) with M855 (SS109) ammo

No room for system variation, shooter error, environ-mental influences



300 meter MER

Confined spaces use = short weapon & barrel length

- **10 shot 13" (330 mm) 300 y**
- **5 shot @ 1" (28 mm) 100 m 55 gr. match ammo (after 12K rds)**
- **10 shot @ 3.5"(89 mm) 100 m groups M855 ammo, 1.9" (48mm) after 15K rds**
- **Ammo + .7 MOA after 17K**

(LWRC 8" [203 mm] bbl M6A2 PSD 6.8x43mm)

(HK416 10.5" [254 mm] bbl 5.56x45mm)

(SCAR L)

Improved system accuracy increases hit probability under normal and worse case scenarios:

- Extended ranges
- Shooter error
- Stress
- Equipment variables
- Environmental influences

#3 – Probability of Hit (pH)
B – Targeting

Optical/laser sighting/targeting systems enhance & increase pH under most operational conditions.

Multiple, time-consuming and often complex mounting and zeroing procedures required for 3 or more separate devices
- **BUIS**
- **Laser pointer**
- **Reflex sight**
- **Other (Thermal, Magnified Optics)**

- Integrated Reflex Sight & Laser Pointer – XM8 ISM, AMO
  - Single zeroing procedure
  - Single power source
  - Single mount – reduced footprint, lighter
  - Single pressure switch – wireless

- PCAP's Mounting Interface
  - "Negative" accessory mounting footprint
  - > 1 lb. (.45 kg) weight reduction – no front end weight penalty
  - Improved zero retention over P rail
  - Reduced cost (@ $300 USD)

Integrated mounting points and/or aiming devices reduce system weight and improve weapon handling aspects and pH.

#4 – Ease of Use
A – General

Soldier survivability is enhanced when small arms are easy to use, simple to maintain and instinctual in their application under stress.

- **Similarity to "Legacy" weapons is desirable for current troops, <u>but may force system compromise for optimum performance</u>**
- **Smart "Clean Sheet" approach yields advantages for new troops and their organizations.**
- **Instinctual controls improve response time on target, under stress, in CQB.**
- **Simplified and/or minimized system upkeep insures reliable function.**

- Similarity of controls (SCAR, HK416) with advanced functional characteristics
- Op Rod Gas Systems* insure:
  - Improved function & safety
  - Reduced maintenance interval (up to 15K rounds) and duration of operator cleaning (3 vs. 15+ mins.)

(* 15 of 20 sample weapons use Op Rod Gas Systems)

- Fully ambidextrous controls improve response time of operators (XM8)

In armed encounters:

- Reliable function
- Speed of engagement
- Precision

Equals user survivability

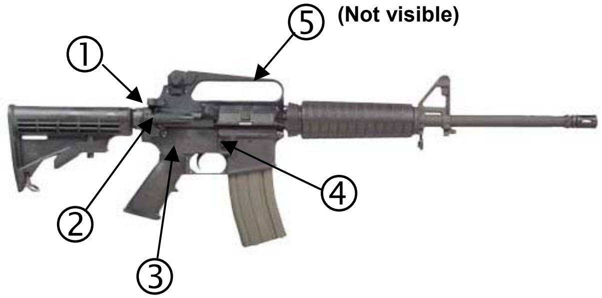
#4 – Ease of Use

B – Ambidextrous & "Centralized" Controls

"Fighter Joystick" strong hand controls offer speed of response, reducing multiple unnecessary and time consuming hand movements, improved muscle memory, and passive control status, and free the weak hand to support/aim the weapon, change magazines, operate the charging handle and perform other non-weapon tasks.

Legacy weapons have distributed controls positioned at multiple and often hard to find/reach locations and seldom are fully ambidextrous.

1. Charging handle
2. Forward assist
3. Safety/selector lever
4. Magazine release
5. Bolt catch/release



Five separate controls/control locations

State-of-the Art Systems

Concentrate like-controls @ the trigger:

First location:

1. Magazine catch/release
2. Bolt catch/release
3. S/S lever

Second location:

4. Charging handle
5. Forward assist

XM8

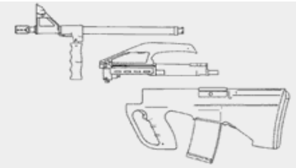
Strong hand activation of multiple controls speeds response time while allowing the weapon to remain in a ready firing position at all times.

#4 – Ease of Use
C – Modularity

The ability of the operator to reconfigure the assigned weapon in the field without special tools to adapt to ever-changing mission and operational environments and threats.

Legacy modularity is most often limited to the exchange of complete upper receivers (where applicable) with few offering buttstock or barrel modularity or caliber conversion.

Modular user-replaceable sub-assemblies offer a wide range of weapon flexibility available on user demand:



- Barrel lengths (AUG, Masada. SCAR 4-6 mins)
- Buttstock modules (XM8, HK33K)
- Trigger groups (G36, XM8, HK33K)
- Caliber conversion (ACR/MASADA, AUG, ARX 160. AR-style systems – upper receiver replacement)

•$1.2B USD projected savings over life-of-system by fielding a family of modular weapons, $12M USD to conduct the competition.

2 Aug 2005 Business Case Analysis.

For use in current fluid operational environments a modular reconfigurable family of weapons would offer:

- **CQB to DM/AR flexibility from a single platform (bbl, sights, stocks, trigger group)**
- **Adaptable ammunition performance (pistol caliber to 5.56x45mm NATO to medium caliber [6.5mm, 6.8mm])**
- **Enhanced terminal ballistics from short-barreled platforms for confined spaces use**

#5 – Lethality

5.56x45mm NATO M855 ammunition provides diminishing terminal effects < 2,500 fps (762 mps) striking velocity due to reduced fragmentation and/or yaw.

***L85A2 has a 20.4" (518mm)barrel!**

- **150 m from 14.5" (368 mm) barrel**
- **0 m from a 10.4" (264 mm) barrel**

Compliance with Hague Convention limitations restrict the use of superior LE-style "deforming" projectiles that improve terminal performance at < 2,500 fps (762 mps), especially through intermediate barriers (clothes, magazines, car panels, wind shields).

- **"Medium caliber" (6.8x43mm Rem. SPC, 6.5mm Grendel, 7.62x39mm)** user installable conversion kits (upper receivers, barrels, bolts/magazine) provide enhanced (up to 55%) terminal performance at the lower striking velocities often obtained from short-barreled carbines desired for confined spaces use.
- **8" (203 mm) bbl LWRC 6.8x43mm PSD 115 gr. OTM @ 300m.**
  - 318 mm (12.53") 10-shot group (3 group average)
  - 450 mps (1475 fps)
  - 949 j (700 ft. lbs) ME remaining
- **14.5" (368 mm) bbl 5.56x45mm Carbine 62 gr. M855 @ 300 m.**
  - 650 mps (2,133 fps)
  - 834 j (615 ft. lbs.)
- **Newly emerging "BTB" ammunition – equal performance through intermediate barriers <u>and</u> unprotected targets.**

Improved terminal performance on protected targets with medium caliber conversion kit while retaining NATO standard ammo compatibility as required for training, interoperability

#6 – System Weight

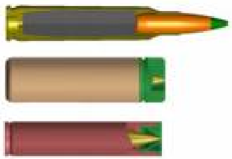
The elusive and highly desirable attribute all soldiers want (yet seldom acquire).
Second in importance to reliability and performance
(á la US M240B 28 lbs, US M60 21 lbs.)

70 kg (155 lbs!)

Even with the liberal use of lightweight materials such as aluminum and polymer since the 1960's the infantryman's combat load continues to increase as new capabilities such as MRS and optical aiming devices are added with no change in ammunition or magazine weight (poly mags same as aluminum) .

- Limited possibilities to reduce rifle weights while retaining desired features and performance
- Accessory mounting and combined function – @ 20% weight reduction (XM8)
- Increased accuracy and terminal performance can increase kills/rounds fired
- Lightweight sights/sight mounting, ammunition technology offers the greatest weight savings:
  - Polymer Case (US LSAT Prog.) > 40%
  - LW Stainless Steel Case - @ 20%
  - **Caseless – too problematic for field use**

Leverage emerging lightweight case material, ISM's, PCAP's and BTB projectile technology to reduce system weight while increasing terminal performance
= more kills/pound
= more kills/round

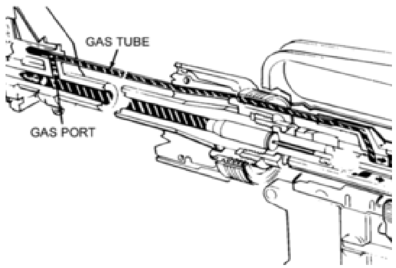


(20% of 70 kg = 56 kg (124 lbs!)

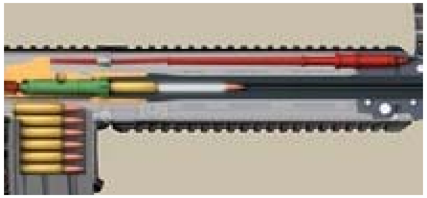
#7 – Maintenance

Reducing the frequency and duration/difficulty of mandatory operator maintenance can insure user compliance and thus system readiness when called upon.

Direct "impingement"-style gas systems common in Stoner AR-15/M16-style platforms contaminate key working parts, burn-off lubrication, create hard baked-on carbon fouling that reduces proper function and requires extensive (unnecessary) cleaning (@ 1,000-5,000 rounds).



- **Op Rod Gas Operated weapons (HK416, G36, SCAR, etc., etc., etc.)**
  - **Reduce cleaning time by > 72% (3 vs. 15+ minutes)**
  - **Reduce the interval of cleaning (> 15K rounds: HK416) and lubrication**
  - **Can operate w/ minimal lube in dusty environments (and reapplication at > 5K rds) and correspondingly increase reliability and weapon readiness**



- **System reliability is the most important aspect of a combat weapon for soldier survival**
- **More than 17 new Op Rod designs since 2004 in the US alone**
- **Good news is most AR's (15 out of 20) and new designs are using Op Rod Gas Systems. AR15/M16 and clones are prime holdouts of the direct gas system.**

#8 – Service Life

Improved (modern) performance specs can result in increased piece part and system service life, resulting in substantially reduced life-cycle costs and improved system performance.

- **Bolt = 6-10K rounds**
- **Barrel = 3-6K rounds**
- **Magazine = < 12,000 rounds**
- **Receiver = @ 50,000 rounds**

- **Bolt = 15,000 – 24,000 rds.**
  (HK416, SCAR L, XM8)
- **Barrel = 24,000 – 35,000 rds.**
  (HK416, SCAR L, XM8)
- **Magazine = 17,000 rds.**
  (XM8, G36)
- **Receiver = 100,000 rds.**
  (SCAR, G36)

Modern System Cost
(Purchase vs. Life-cycle)
Legacy vs. Superior COTS
(SCAR L, HK416)

SEE NEXT SLIDE

* EQUAL PURCHASE COST!

Purchase Cost vs. Life Cycle Cost - Weapon

Item	Unit Cost ($)	÷ Service Life [1] (# rounds) =	Cost (cents) per rd. fired	X 20,000 rd. Life Cycle Cost =	X Division Cost (18K) =
US Standard Weapon	$1,000 (Qty K's)	6,000 [2]	17	3,400	$61,200,000
Superior COTS Weapon	$1,425 (Q 1)	24,000 [3]	.06	1,200	$21,600,000
Superior USG Weapon	$1,800 (Qty K's)	35,000 [3]	.05	1,000	$18,000,000

- Superior Weapons 3.4X less costly to maintain over projected 20K round service life.
- Superior weapons offer 67% lower life cycle costs.

- Costs do not include: Armorers repair time/cost/training, piece parts, replacement effort for user, logistical burden, serial number accountability, operator safety, confidence, survivability.

[1] # rounds that can be fired before parts replacement. [2] US MIL SPEC [3] USG test data Q = Quantity K = Thousands 1 = one

#9 – Performance

“Conventional” vs. “Bullpup” Configuration

Rifle/carbine layout is mostly driven by user specifications written by legacy users (“old timers”) without equal consideration of overall system performance in the hands of all users.

Two strong trends in recent years:

- **Product improvements in conventional legacy systems (HK416, Stgw. 90, L85A2)**
- **Trend towards bullpup configuration (F2000, QBZ-97, TAR-21, A-91, SAR-21)**
  - **Improved terminal ballistics**
  - **Shorter system length – improved handling**

5.56mm Bullpup vs. Conventional
(Carbine length)
Size vs. Terminal Performance


classic design - AK74


bullpup design - Steyr AUG

	Conventional	Bullpup	Bullpup Difference	%
• OL mm (in.)	854 (33.6)	754 (2.93)	-112 (4.3)	-12
• Barrel Length mm (in.)	332 (13.1)	468 (18.4)	+136 (5.3)	+29
• MV mps (fps)	835 (2740)	940 (3084)	+105 (344)	+11

- **<u>Clear advantage</u> in handling, terminal effects, portability and confined spaces use with bullpup configuration.**
- **Only arguable disadvantages are "manual of arms” and prone magazine changes.**
- **How about a medium-caliber Bullpup with 18” bbl in 6.8x43mm @ 3,196 fps (974 mps) w/ BTB ammo?**

Bullpup Configuration

Comparison Table 10 current/modern Bullpup-configuration Carbine-length Assault Rifles											
Weapon	**FAMAS**	**AUG**	**F2000**	**QBZ-97**	**TAR-21**	**SAR-21**	**Vector CR-21**	**L85A2**	**A-91**	**Valmet M82**	**Averages**
Overall Length mm/(in.)	**757 (29.8)**	**805 (31.7)**	**694 (27.3)**	**760 (29.9)**	**720 (28.4)**	**805 (31.7)**	**760 (29.9)**	**780 (30.7)**	**660 (26.0)**	**710 (28.0)**	**745 (29.3)**
Barrel Length mm/(in.)	**488 (19.2)**	**508 (20.0)**	**400 (15.8)**	**520 (20.5)**	**460 (18.1)**	**508 (20.0)**	**460 (18.1)**	**518 (20.4)**	**400 (15.8)**	**420 (16.5)**	**468 (18.4)**
Muzzle Velocity mps/fps	**960 (3156)**	**940 (3084)**	**920 (3019)**	**930 (3051)**	**910 (2986)**	**N/A**	**980 (3215)**	**940 (3084)**	**N/A**	**N/A**	**940 (3084)**
Key Features	**BB**	**OR, QCB**	**OR, FE**	**OR, ACH**	**OR, AE, ECH, LAM SM**	**OR, ACH, LAM**	**OR**	**OR**	**OR, FE, ACH**	**OR**	**OR - 9/10 FE – 2/10**

Note: Threat Standard (7.62x39 mm AKM) - OL = 870/690 mm (34.3/27.2 in.) Bbl Length = 415 mm (16.34 in.) MV = 710 mps (2330 fps)

Note: Bullpup average OL is 125 mm (4.92 in.) shorter than the AKM (stock extended) and provides @ 230 mps (755 fps) > MV from a 52.3 mm (2.06 in.) longer barrel.

Note: OL on average is only 277(10.9) longer than barrel length.

Key: **ACH** – Ambidextrous Charging Handle **AE** – Adjustable Ejection **BB** - Blowback **ECH** – Exchangeable Charging Handle **FE** – Forward Ejection **ISM** – Integrated Sight Module (reflex sight/lasers) **LAM** – Laser Aiming Module **OR** - Op Rod Gas System **QCB** – Quick-change Barrel (w/o tools) **SM** – Sight Mount permanent to barrel

#10 – Accessories
Enhanced Features

COTS enhancements exist as accessories and/or weapon system technologies to improve system performance.

- Op Rod Gas Systems
- ISM and/or integral LAM vs. multiple targeting devices (2-3)
- PCAP's (XM8) or hard points (SCAR) vs. dedicated MRS (MRS adds 1 lb. [.45 kg] and costs @ $300 USD)
- "Nested" High Reliability magazines (>18K rd. life)
- Cold hammer forged barrel
- SBFA
- Medium caliber conversion option

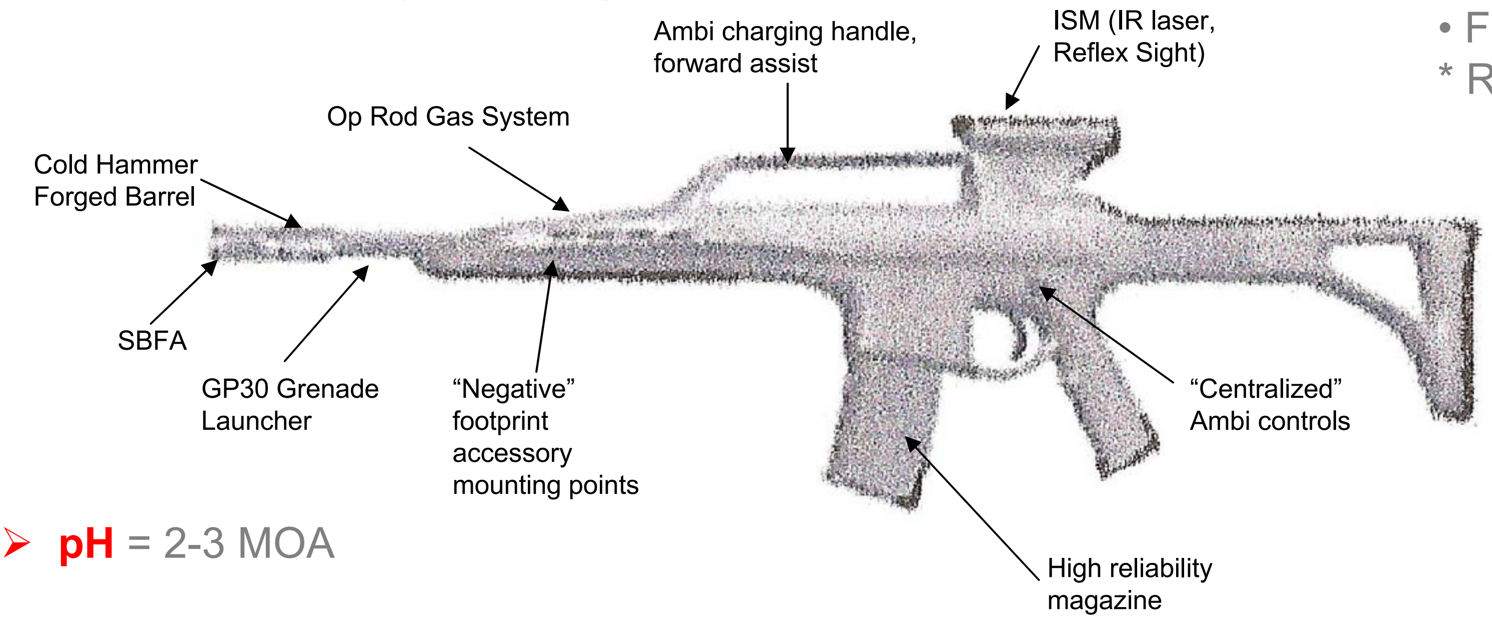
- Russian GP30 40mm add-on grenade launcher

- "Shifted pulse" or "Balanced action" operating systems (AN-94, AEK-971)
- ST Kinetics PPAB 40x46mm LV System – All COTS or near COTS

Available COTS enhancements available today to enhance legacy performance, or to be considered in new systems.

The "Ultimate" Incrementally Superior Conventional Assault Rifle

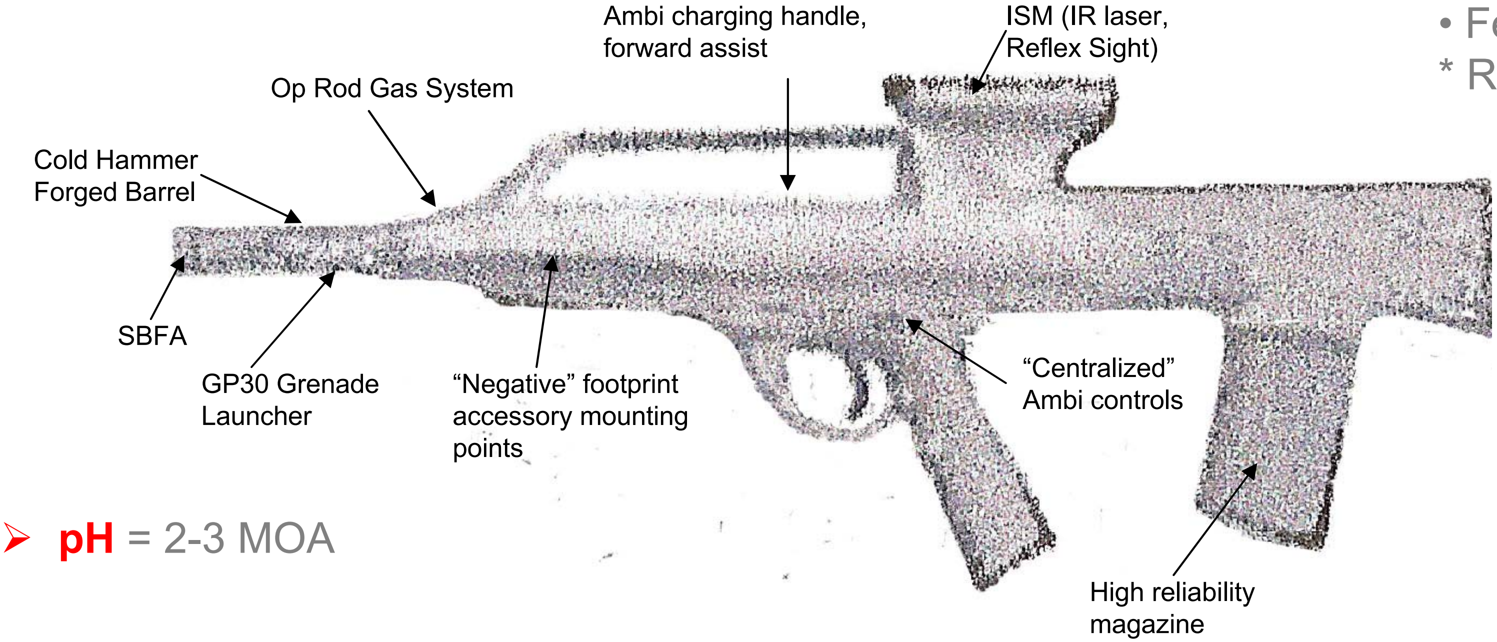
- **Safety**
  - Cook-off =/> 270 rds.
  - Barrel failure =/> 900 rds.
  - OTB Capable (0 seconds)
- **Reliability** =/> 18,000 MRPF/S
- **Family of Modular Weapons**
  - Barrels
  - Stocks, trigger groups
  - Calibers
  - Feed systems
  - * Reduced life cycle costs



- **System weight**
  - =/< 2.8 kg (6.1 lbs.) (XM8 BC)
  - LW ammunition
- **pH** = 2-3 MOA
- **Lethality**
  - BTB projectiles
  - Medium caliber option
  - Increased Terminal Effectiveness against unprotected and protected targets
- **Maintenance**
  - 72% less operator cleaning
  - > 2X bolt service life
  - > 3X barrel service life
  - 2X receiver service life

The "Ultimate" Incrementally Superior Bullpup Assault Rifle

- **Safety**
  - Cook-off =/> 270 rds.
  - Barrel failure =/> 900 rds.
  - OTB Capable (0 seconds)
- **Reliability** =/> 18,000 MRPF/S
- **Family of Modular Weapons**
  - Barrels
  - Stocks, trigger groups
  - Calibers
  - Feed systems
  - * Reduced life cycle costs



- **System Weight**
  - =/< 3.27 kg
    (7.2 lbs.) (TAR-21)
  - LW ammunition
- **pH** = 2-3 MOA
- **Lethality**
  - BTB projectiles
  - Medium caliber option
  - Increased MV (NLT 11%)
  - Increased ME
- **Maintenance**
  - 72% less operator cleaning
  - > 2X bolt service life
  - > 3X barrel service life
  - 2X receiver service life

SUMMARY

- The last 10 years have produced substantial incremental enhancements in small arms and ammo technology (*most notably in potential threat weaponry*).

- With few but partial exceptions these incremental enhancements have not been combined into a single system.

- Too many new developments/procurements are being made using outdated performance specifications and/or legacy user input only.

- The "Ultimate" incrementally superior system could be available in 18-24 months if all inclusive performance specs would be released to industry in a "responsive" program.

- Incrementally superior COTS weapons fielded today will always outperform promised and "unfielded" so-called "Leap Ahead" technologies, and at comparably modest developmental costs!

($430M USD spent in past 20 yrs on "Leap-ahead" programs vs. 0 dollars spent on HK416).

- America is not matching threat weapon/ammunition capabilities and is quickly falling behind in its small arms superiority!

A parting thought…

"Most of the boots on the ground in OEF/OIF will be the first to tell you that the enemy has no respect for our war fighters in a head-to-head confrontation while maneuvering with his individual weapon.

<u>An enemy who does not respect a Soldier's ability to deliver pain or death will always bring the fight directly to the Soldier,</u>

<u>at belt buckle distance."</u>

MSG Steve Holland – 5th Special Forces Group (ABN)

30 year Army veteran, NDIA Hathcock Award Recipient

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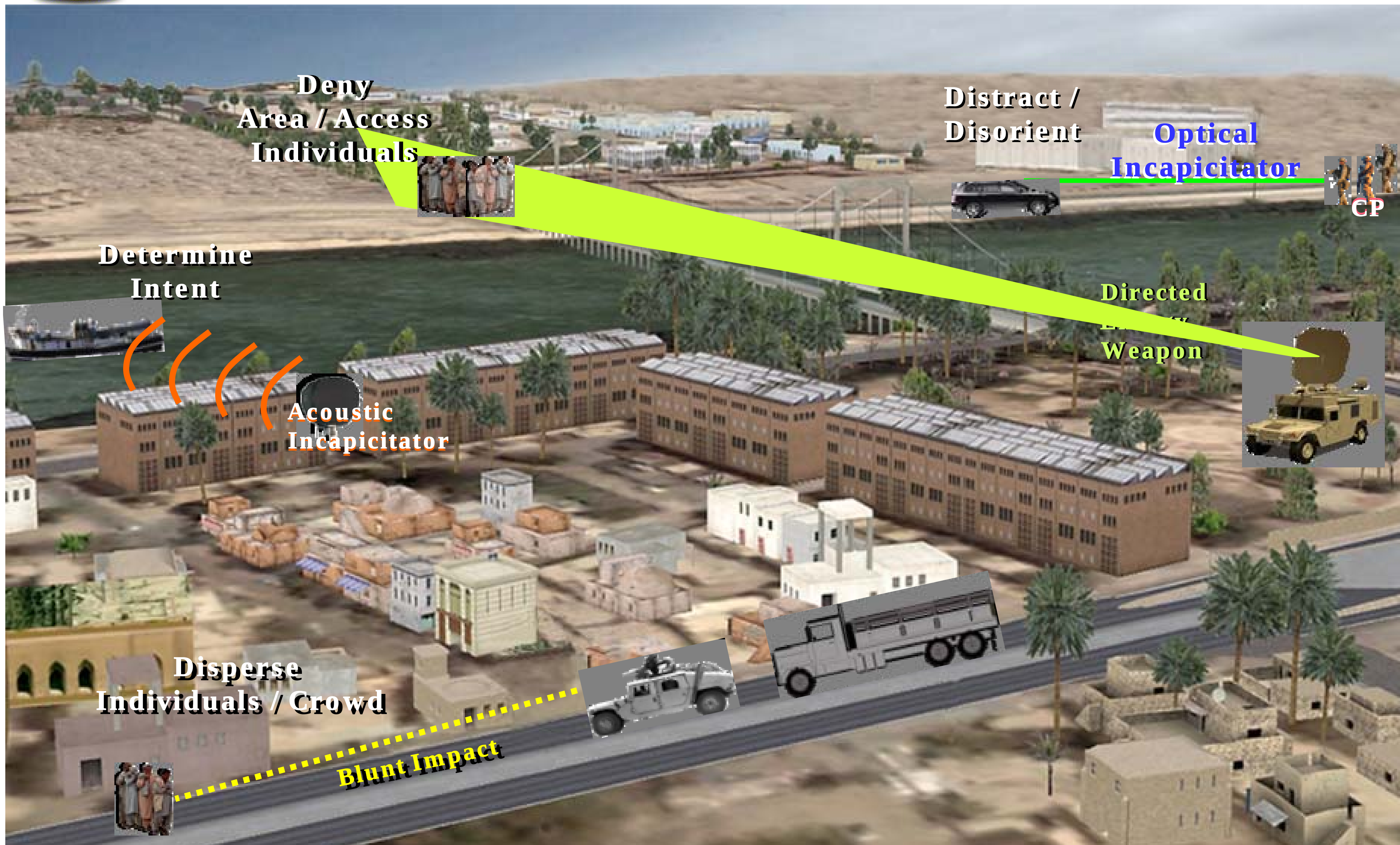
United States of America

JNLWP Update to the International Infantry & Joint Services Small Arms Symposium

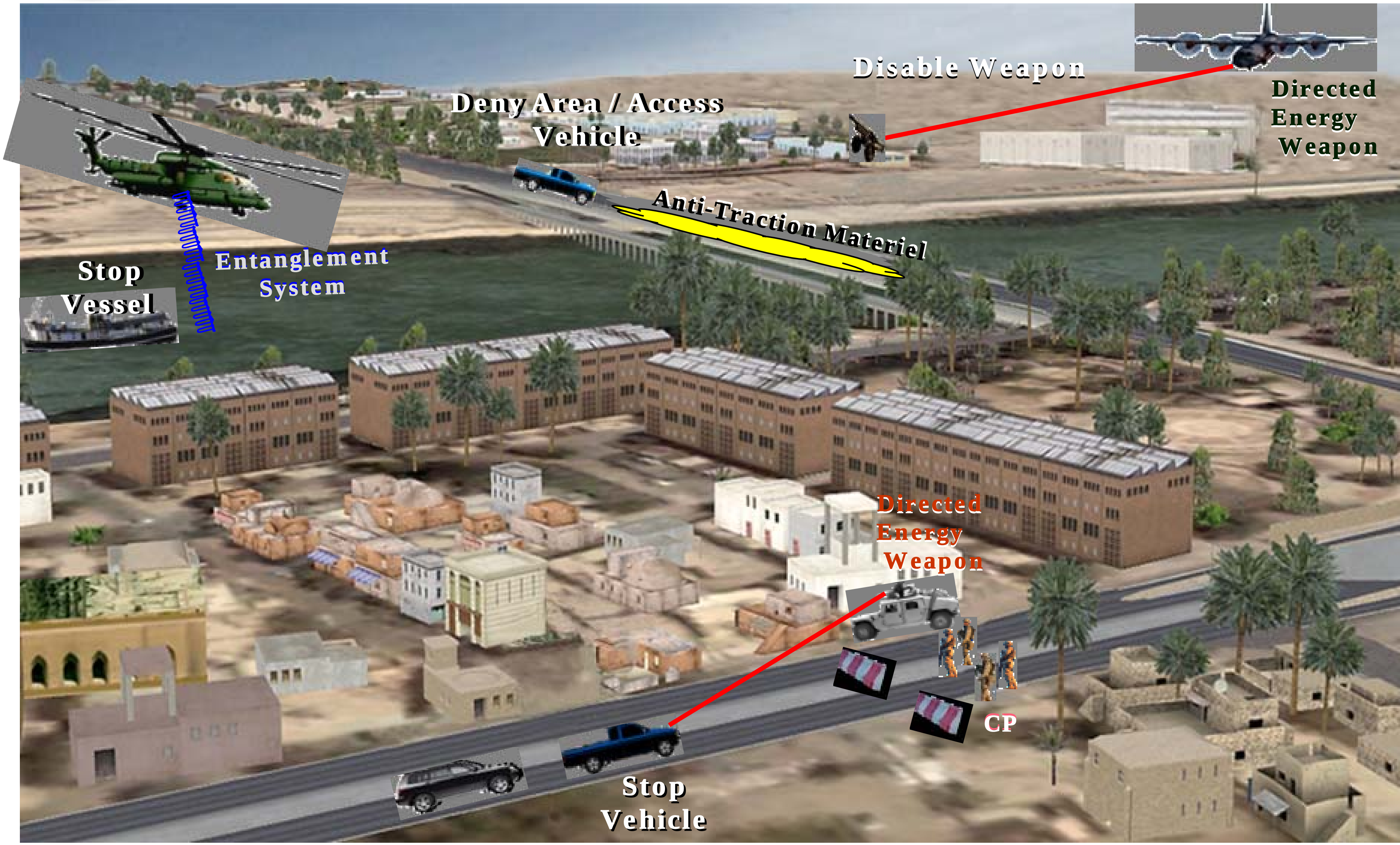
Mr Swenson
Acquisition Division Chief, Joint NL Weapons Directorate
(703)432-0906, DSN 378-0906
kevin.swenson@usmc.mil

22 May 08

COUNTER-PERSONNEL



COUNTER-MATERIEL



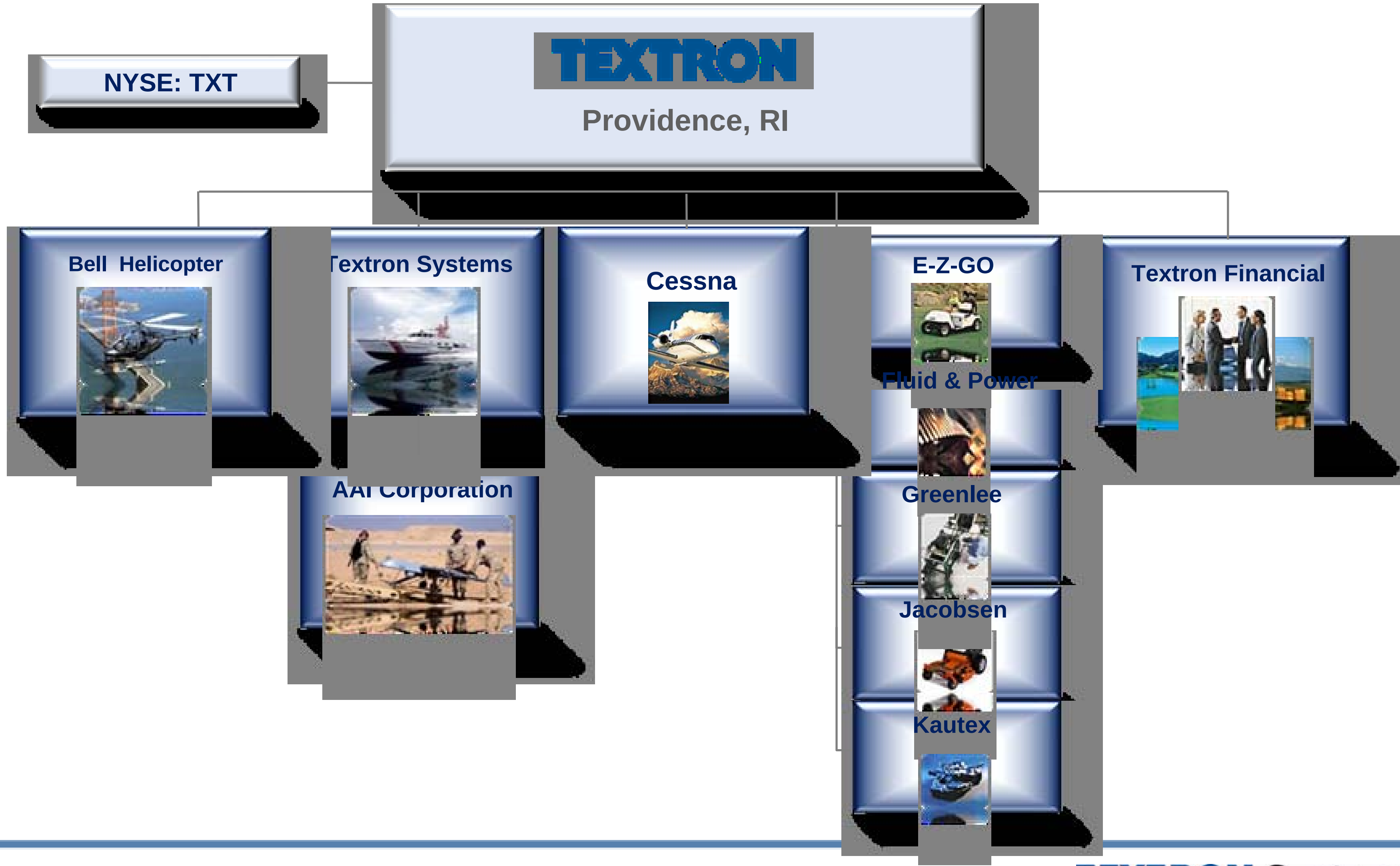
Distribution Statement A – Approved for Public Release

NDIA Small Arms Systems Symposium

Small Caliber Ammunition Panel Discussions

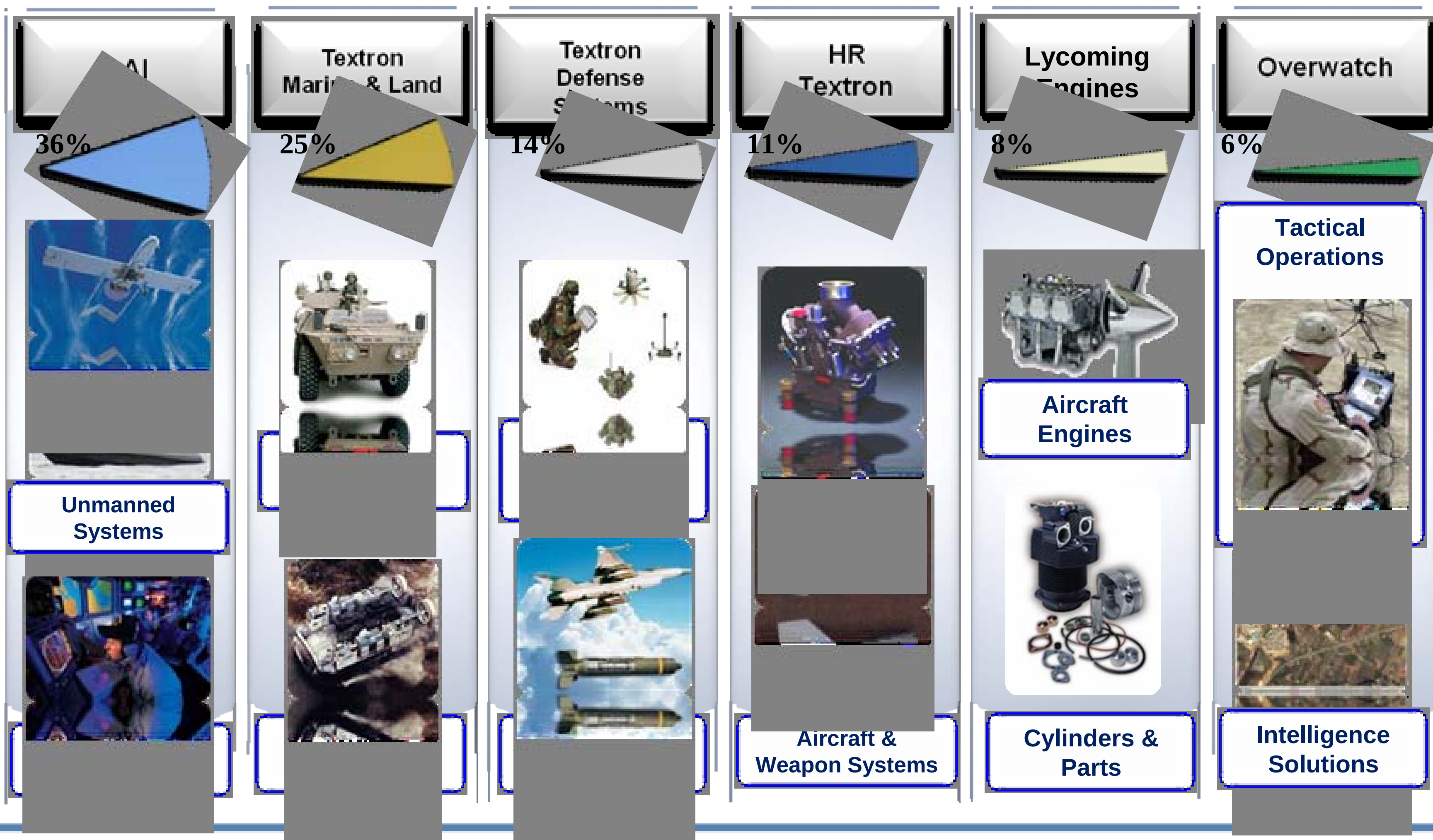
Paul Shipley
21 May 2008

Organization



Textron Systems

% of revenues



TEXTRON Systems

Organization

Textron Inc.
Providence, RI

2007
Revenues: $13.2B
Employees: 44,000

Textron Systems
Wilmington, MA

2007
Revenues: $1.3B*
Employees: 6,500

AAI Corporation
Hunt Valley, MD

2007
Revenues: $0.7B
Employees: 2,450

- Unmanned Aircraft Systems
  - Aerosonde Pty Ltd
  - Pioneer UAV, Inc.
- Services
- Test Systems
  - ESL Defence Ltd.
  - Symtx, Inc.
- Training Systems
- Advanced Programs

*Includes AAI revenues for a 6-week stub period following acquisition.

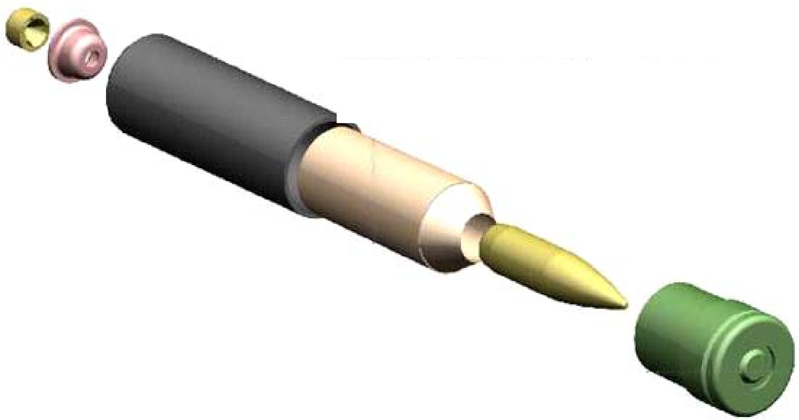
AAI Locations

Advanced Programs

SAMPLES OF AAI ORDNANCE PRODUCTS

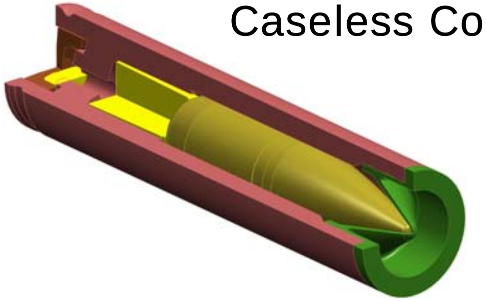
Samples of AAI Small Arms

Ammunition Features



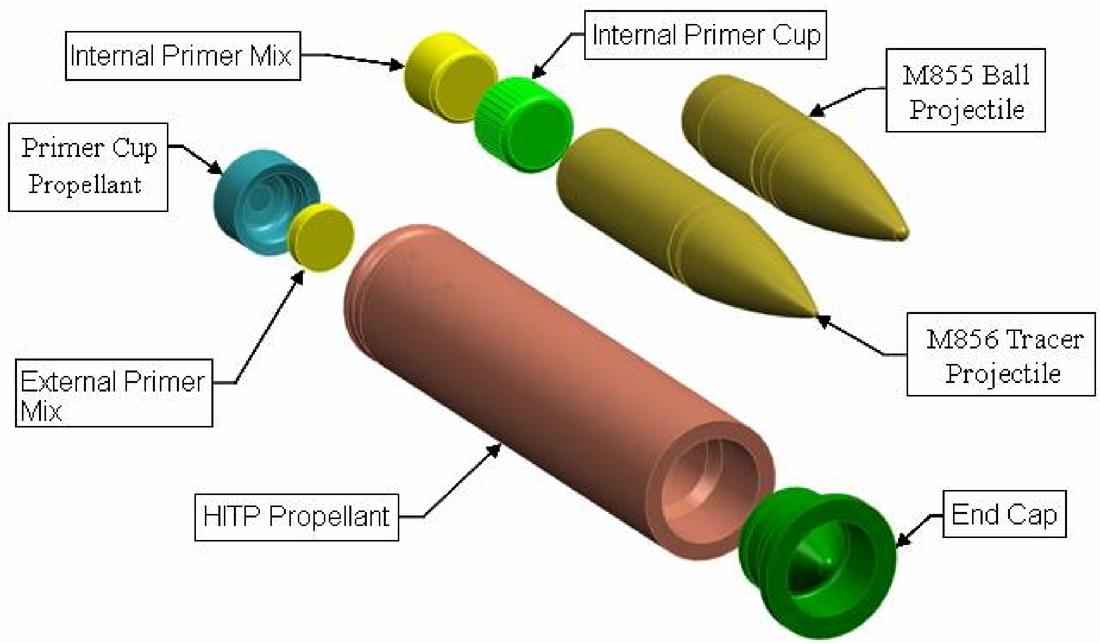
- Conventional technology in telescoped configuration
- 30 – 40% weight reduction
- Lower Risk

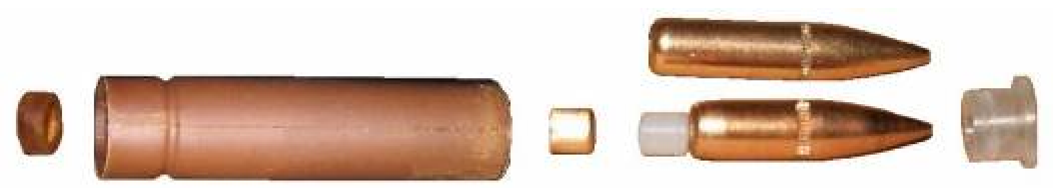
Caseless Configuration



- High Ignition Temperature Propellant Technology
- 50%+ Weight Reduction
- 40% Volume Reduction
- Higher Risk

CL Cartridge Components & Technologies

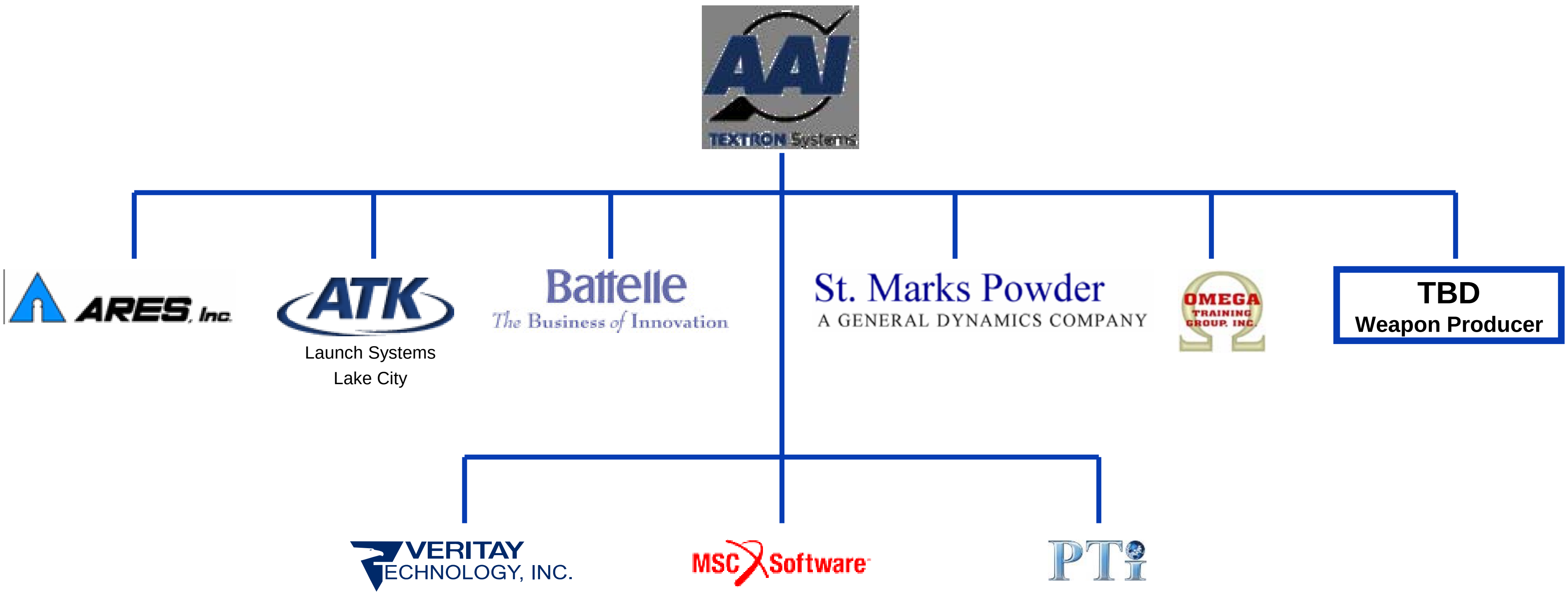




Key Technologies

- **Telescoped configuration**
- **High Ignition Temperature Propellant (HITP)**
- **Internal Primer assisted interior ballistics**

AAI Contractor Team Members



NDIA International Small Arms Symposium, Exhibition & Firing Demo 2008

"Hiram Maxim and His Machinegun:
A great force harnessed to a useful purpose"

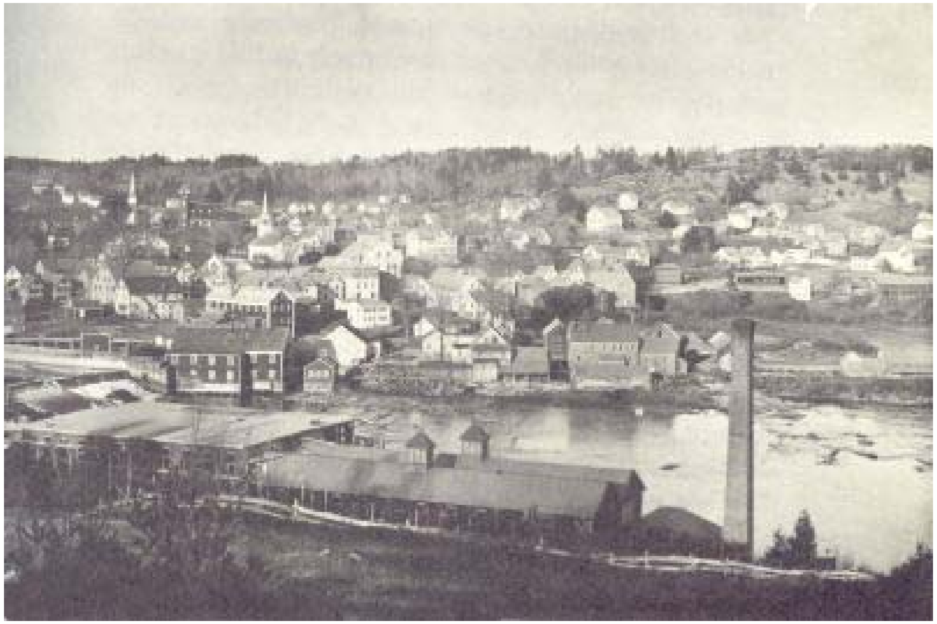
By Stephen C. Small, Ph.D.

as of 1500hrs – 13 May 08

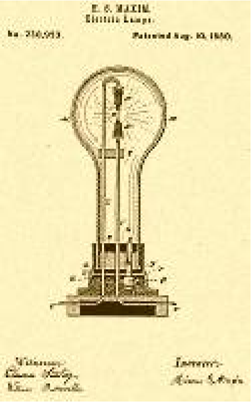
Agenda

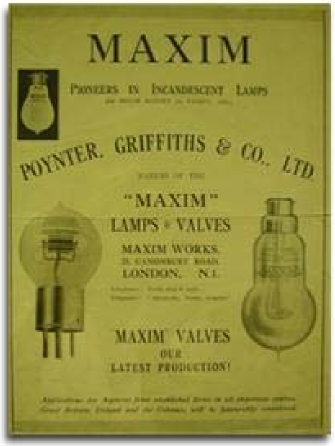
- The Early Years
- His Automatic Machinegun
- Marketing the Maxim Machinegun
- Colonial Wars
- Ordnance Department Tests
- 20th Century Warfare
- The Human Cost
- Summary

The Early Years

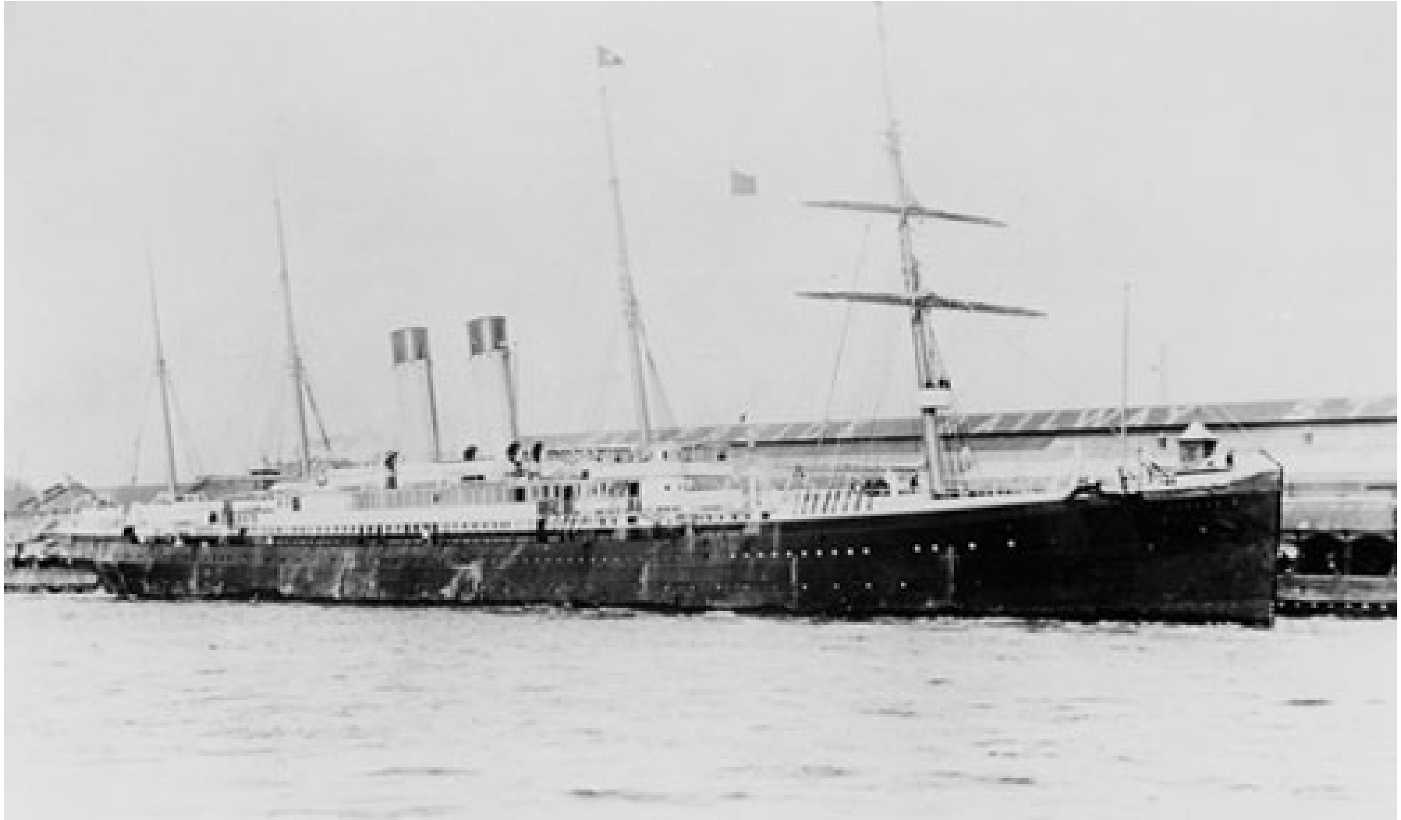


The Young Inventor at The United States Electric Lighting Co.

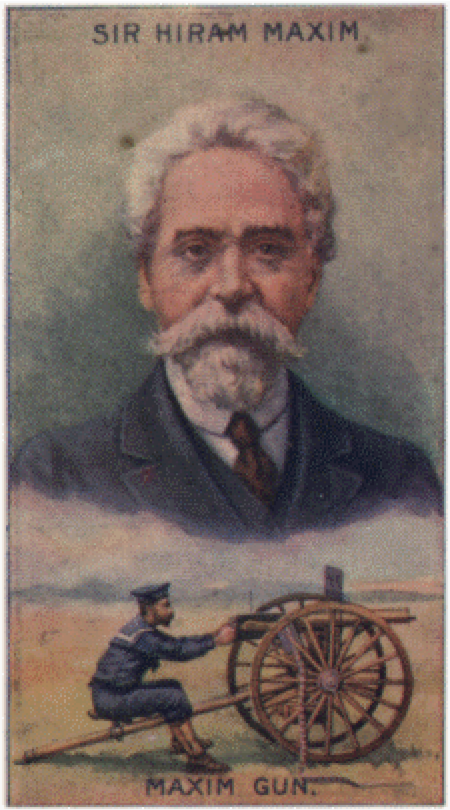




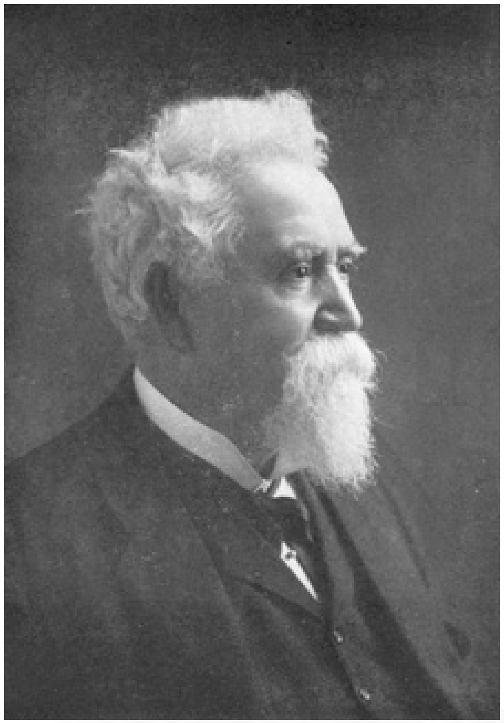
Embarks for Europe

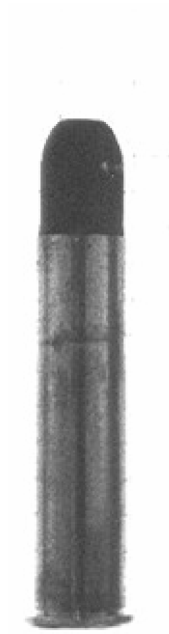


His Automatic Machinegun

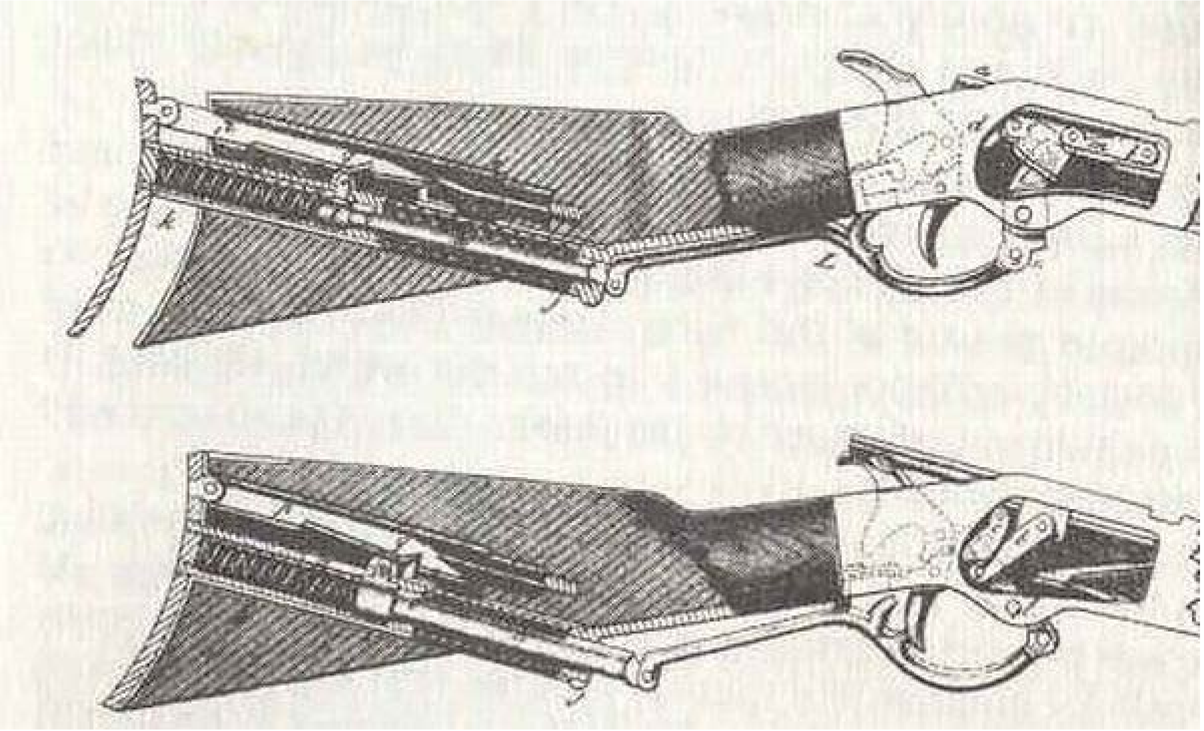


“Cannot this great force be harnessed to a useful purpose?”



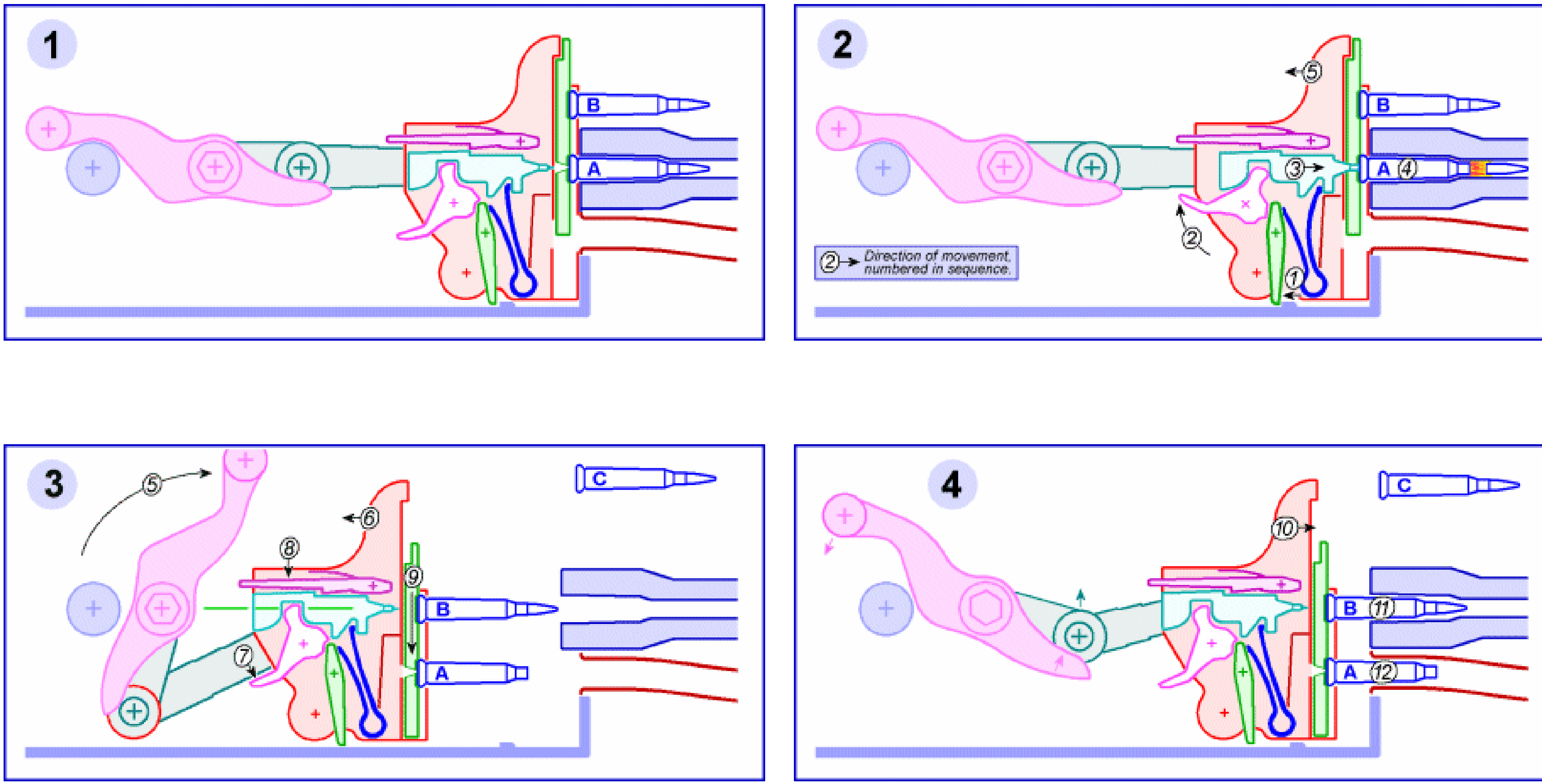


1884: The Initial Attempt

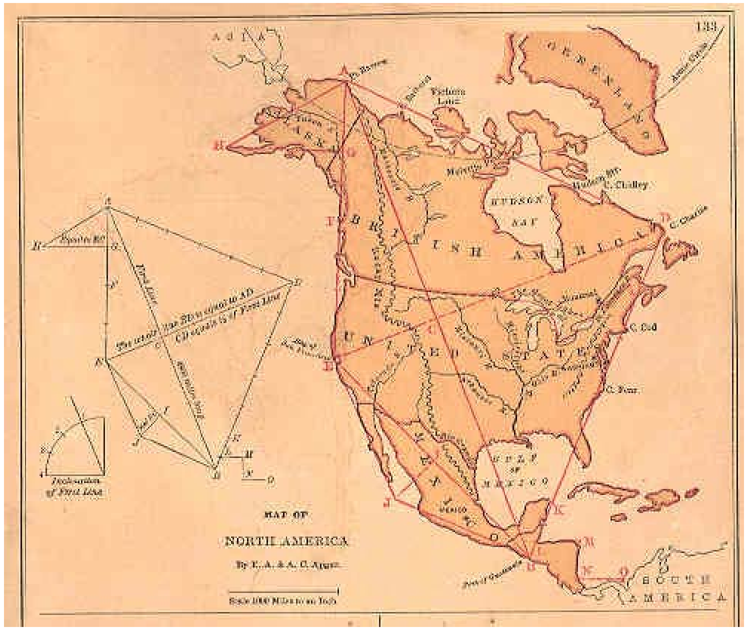


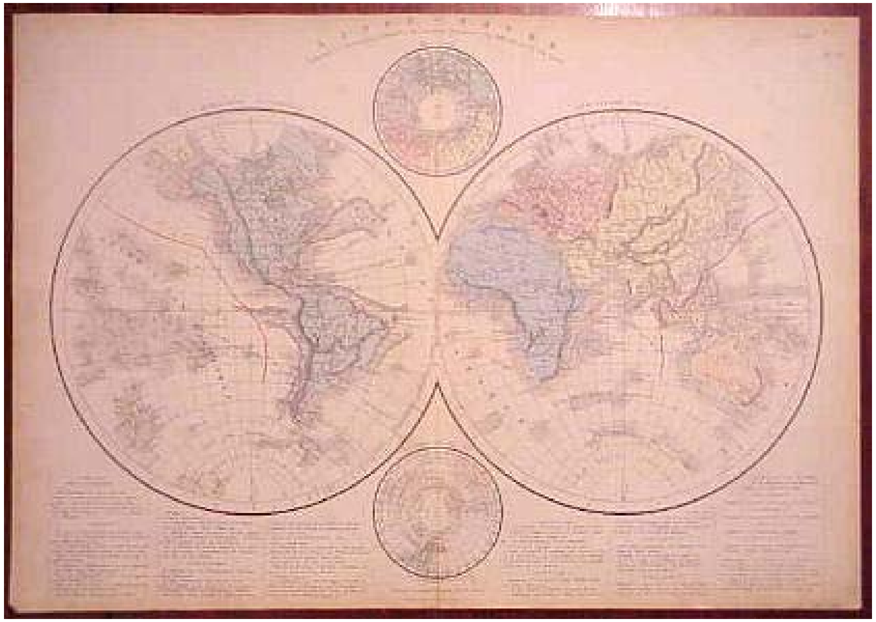
1885: The First Recoil-Operated Machinegun

The principle



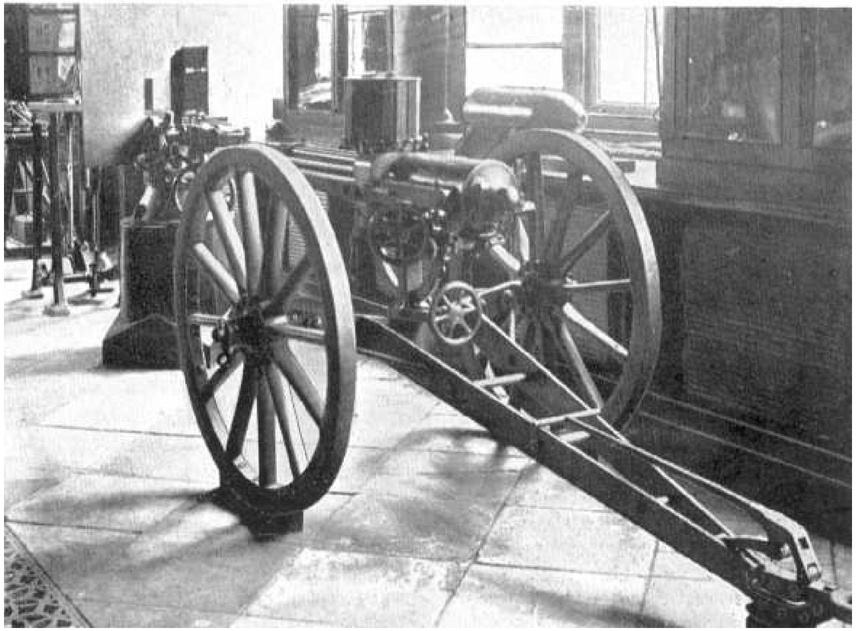
Marketing the Maxim Machinegun





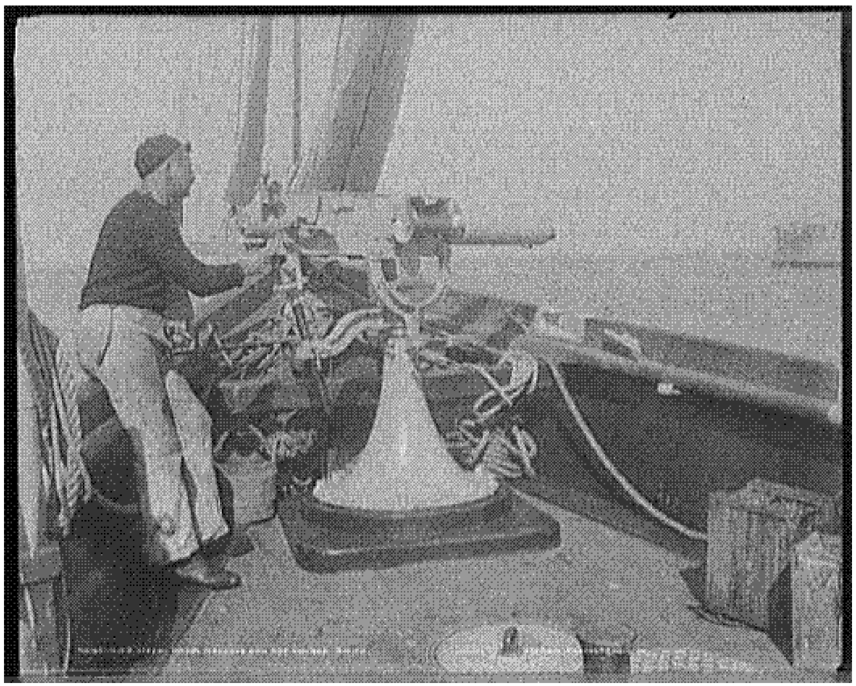
1888: The Testing of the Maxim by U.S. Army

Prototype Maxim Machinegun



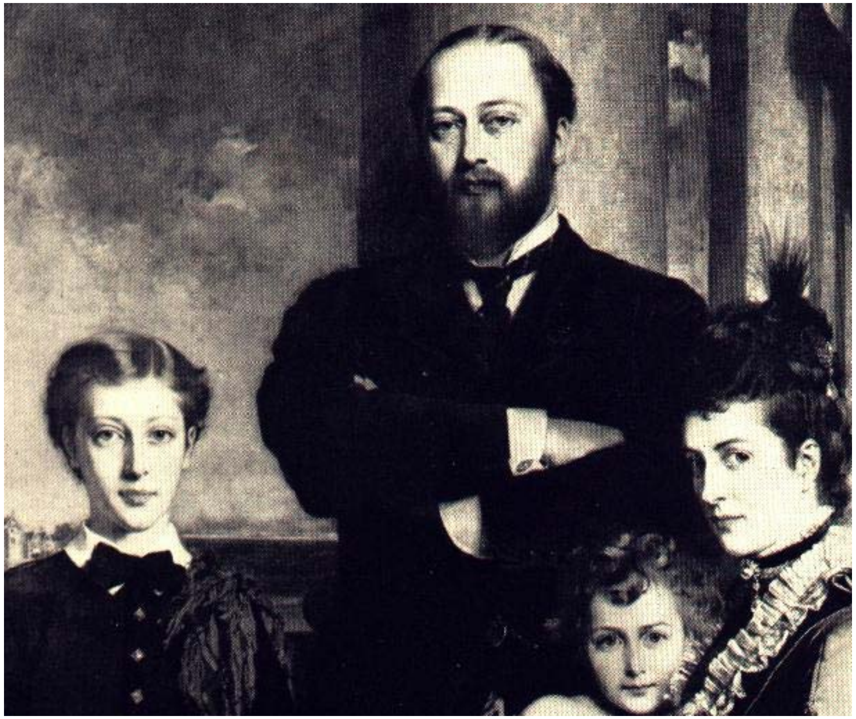
Gatling Gun

The U.S. Navy
Adopts the Maxim "Pom-pom" Gun

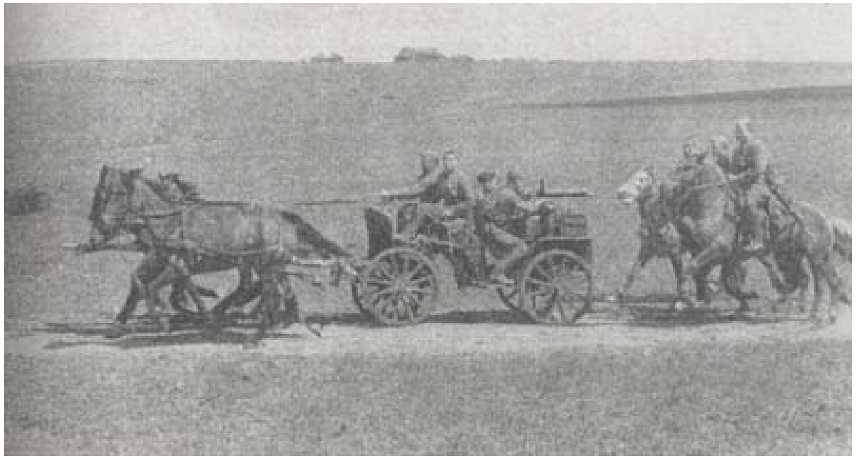


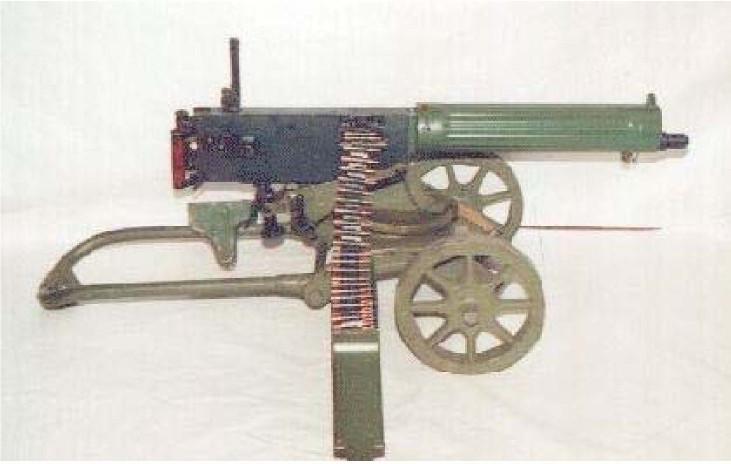
1893: Maxim sold his new weapon to the British Army

The Prince of Wales



The Russian Army





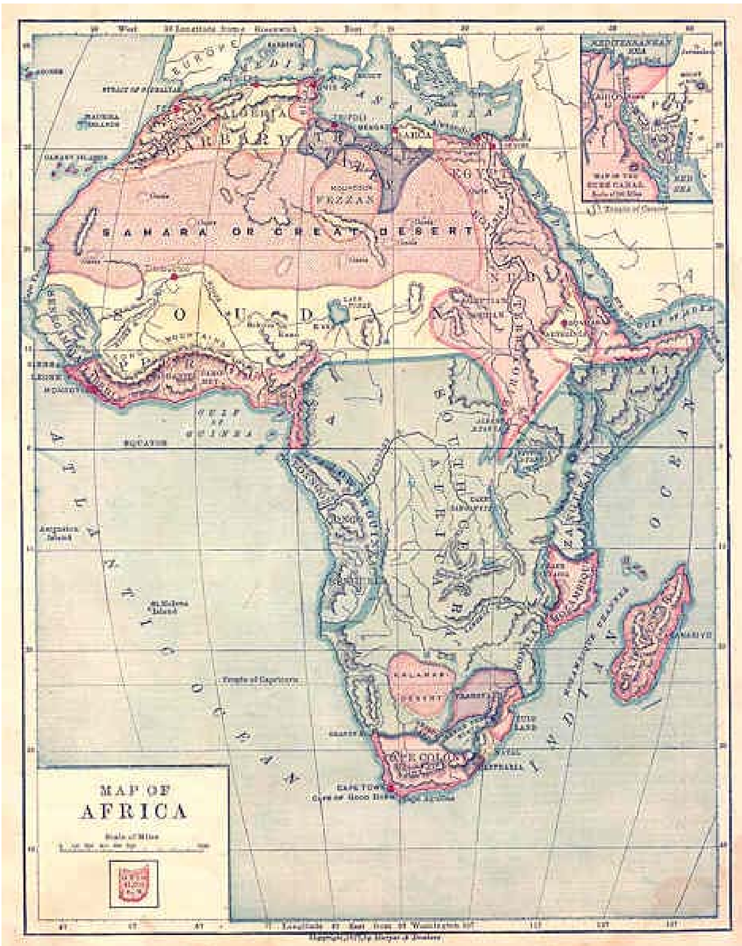
Kaiser William II
“This is the gun; there is no other!”

An International Best Seller

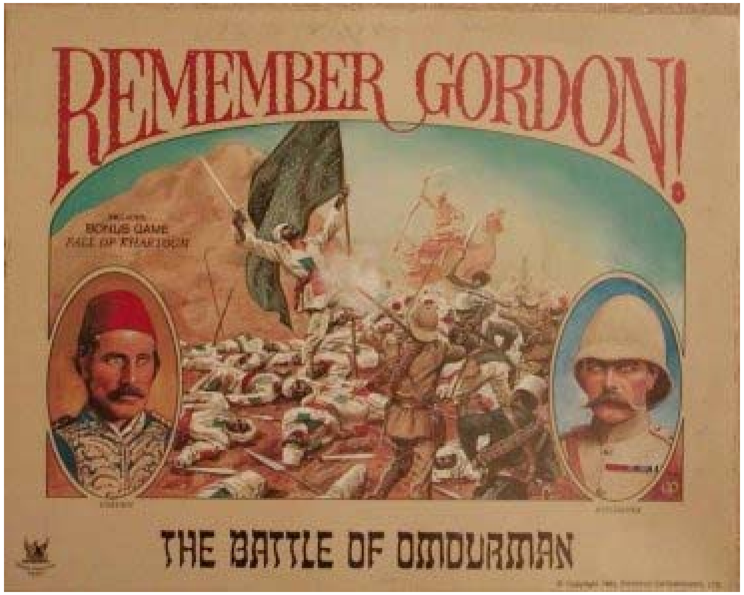
knighthood from Queen Victoria

Colonial Wars and Insurgences

1893: The Matabele War



1898 - The Battle of Omdurman



1899 - Philippine Insurrection

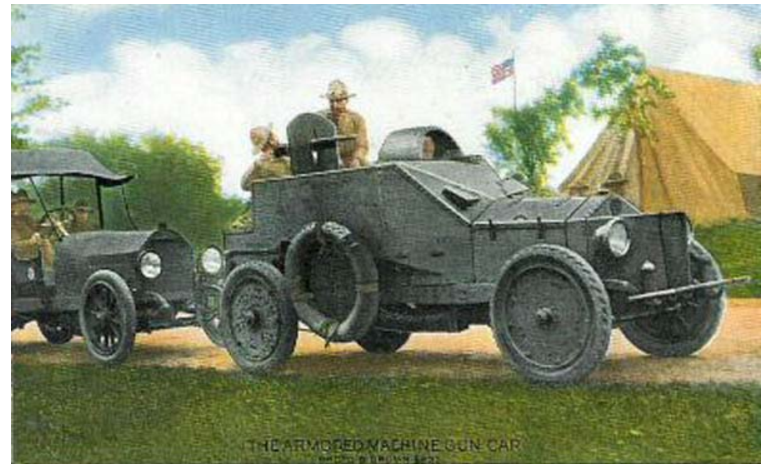
The Ordnance Dept. Tests Machineguns

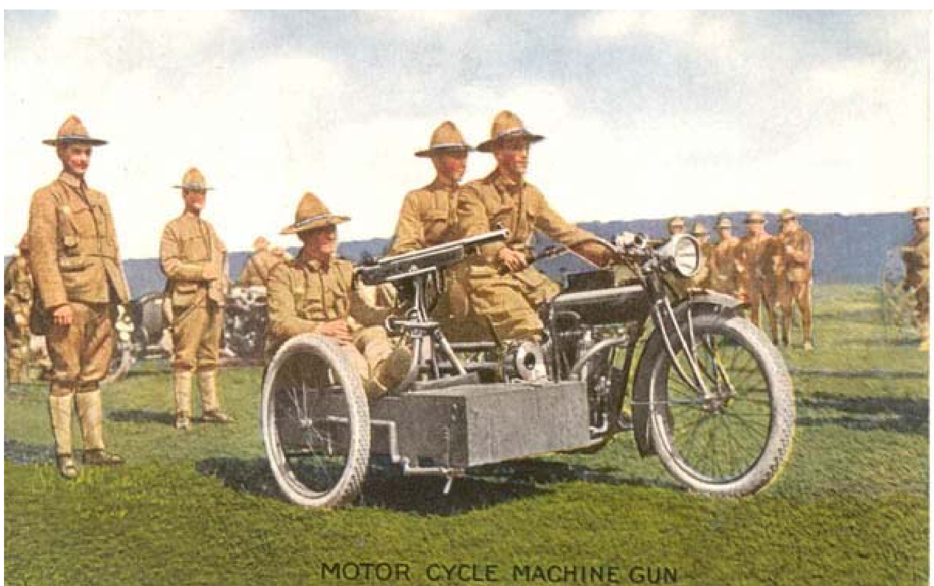
The U.S. Ordnance Dept. Tests the Maxim Gun - Again

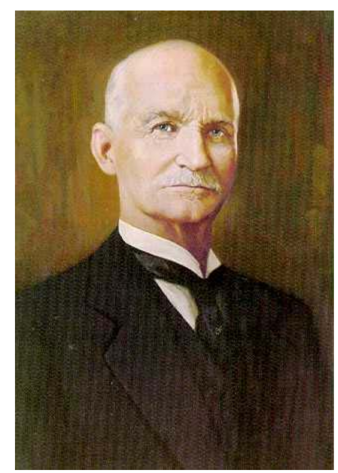
U.S. Army Chief of Ordnance, Brigadier General Buffington

BRIGADIER-GENERAL ADELBERT RINALDO BUFFINGTON

John M. Browning

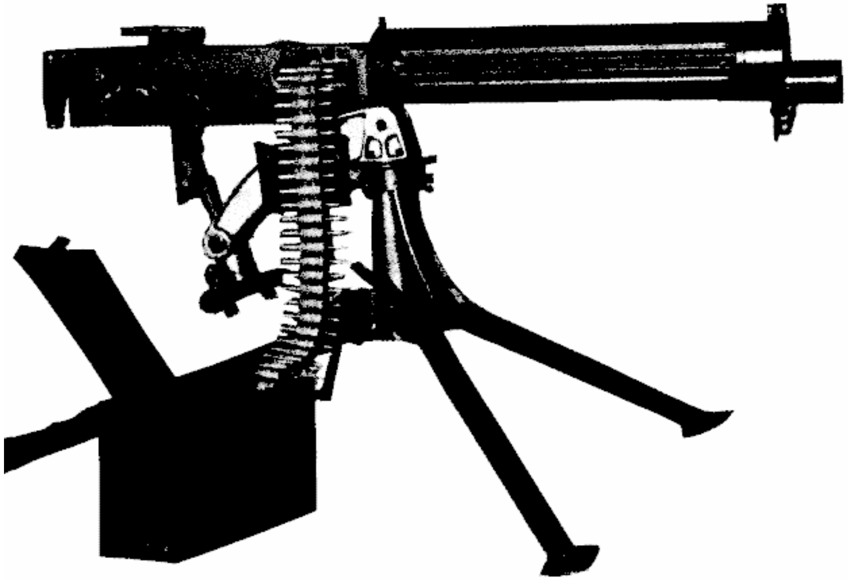






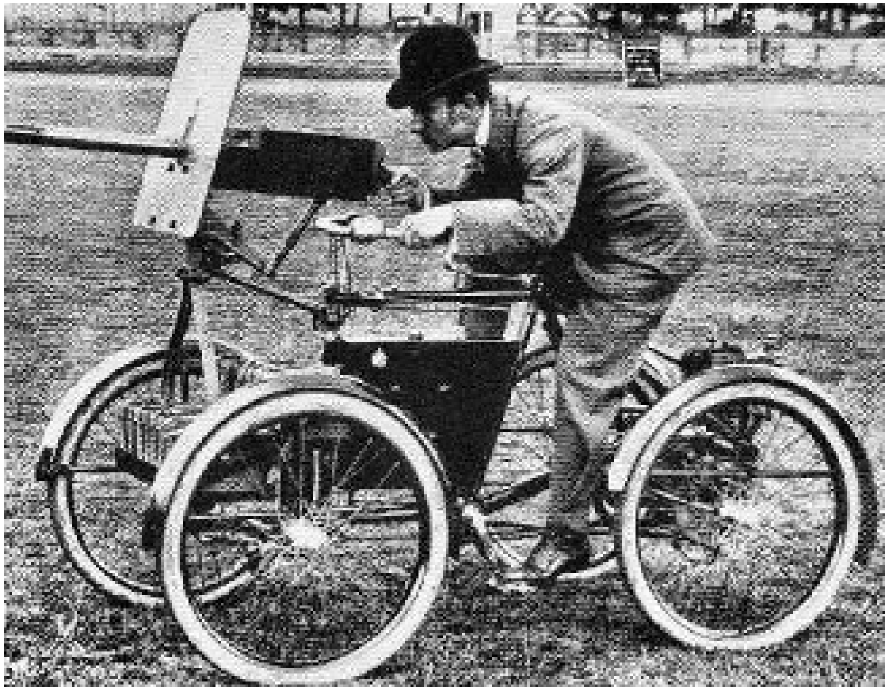
1909: The Benet-Mercie Machine-Rifle

1913: U.S. Army Selects a Maxim "Vickers"



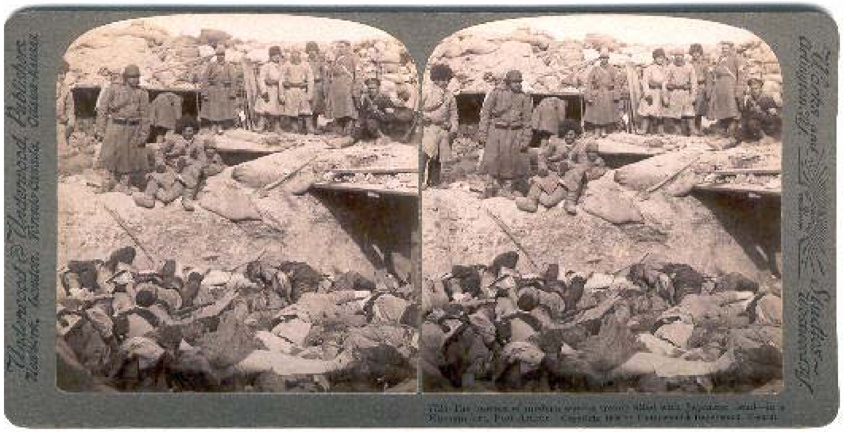
Platform Mounted Maxim Machinegun

Platform Mounted Maxim Machinegun

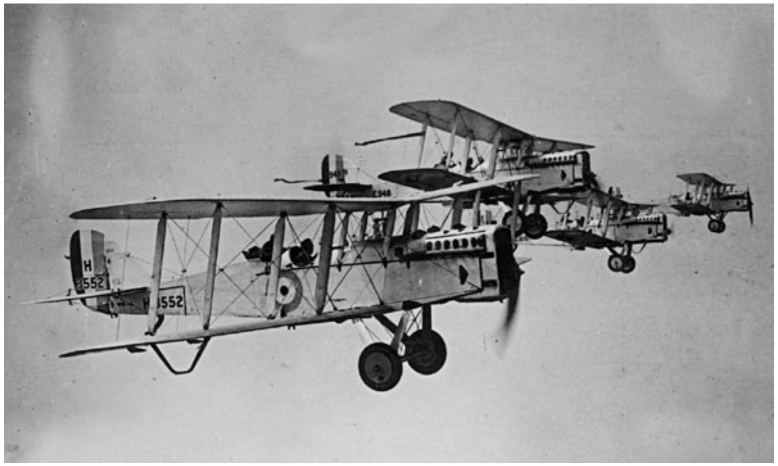


20^{th} Century Warfare

1904-5: The Russo-Japanese War

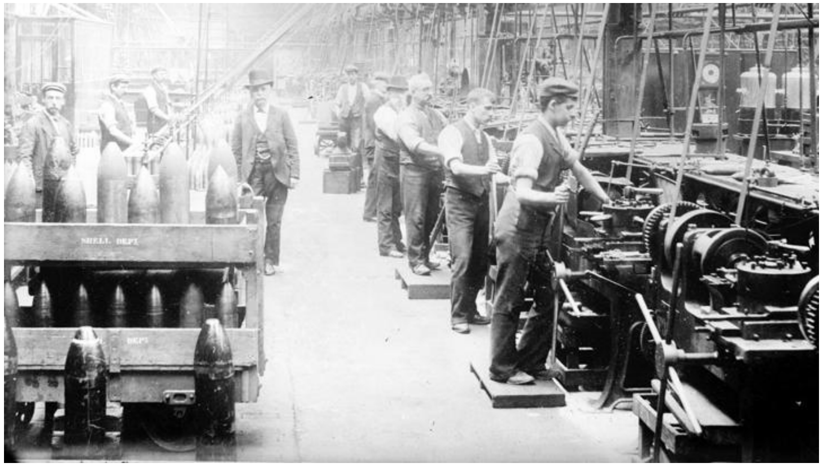


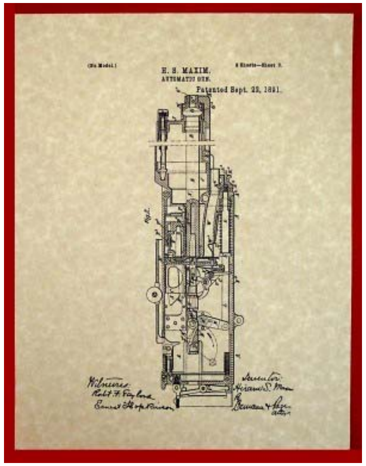
World War I

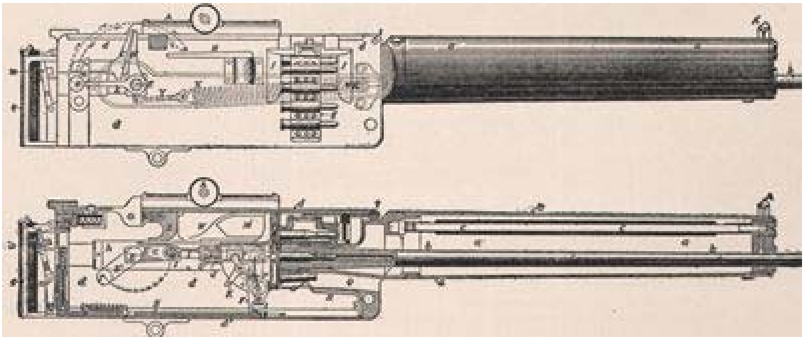


Strengthened Defense

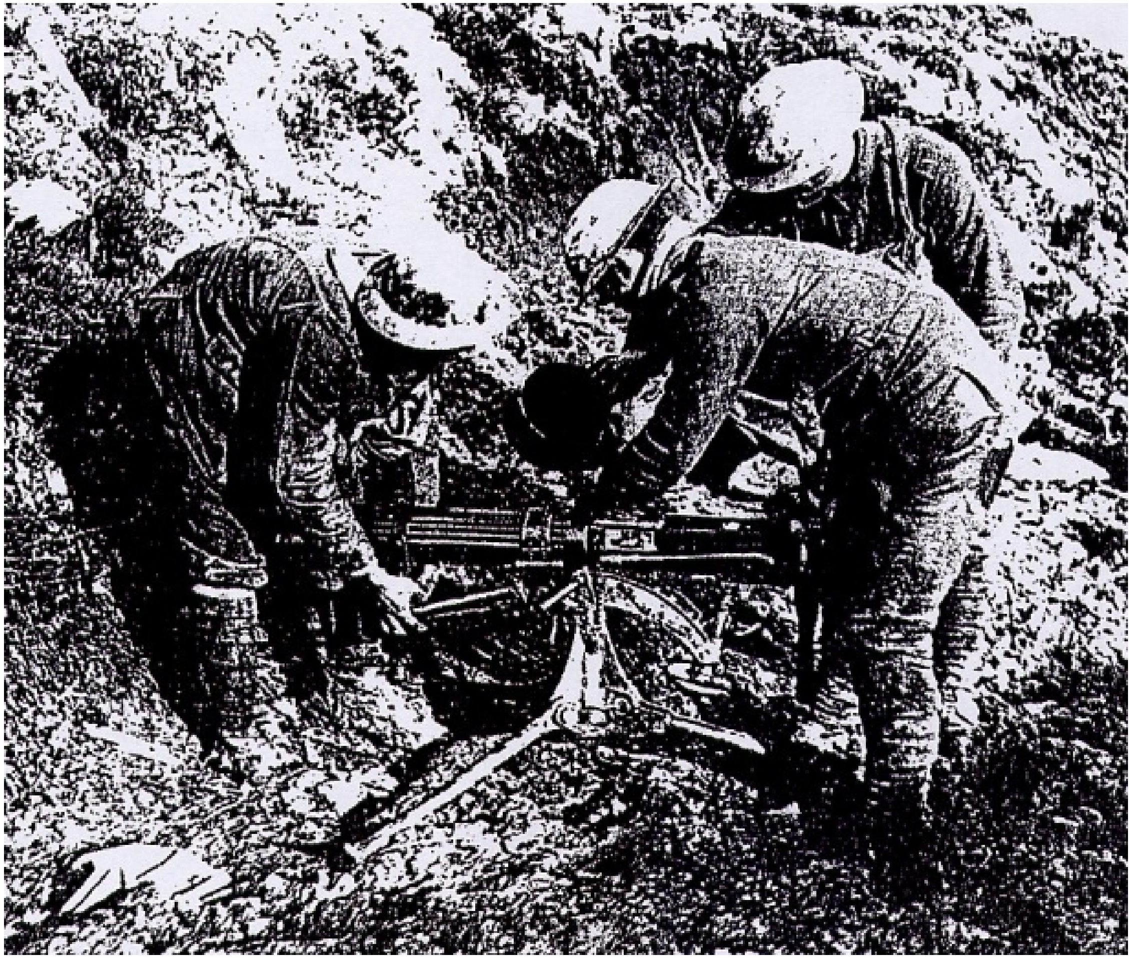
The Engineer’s War



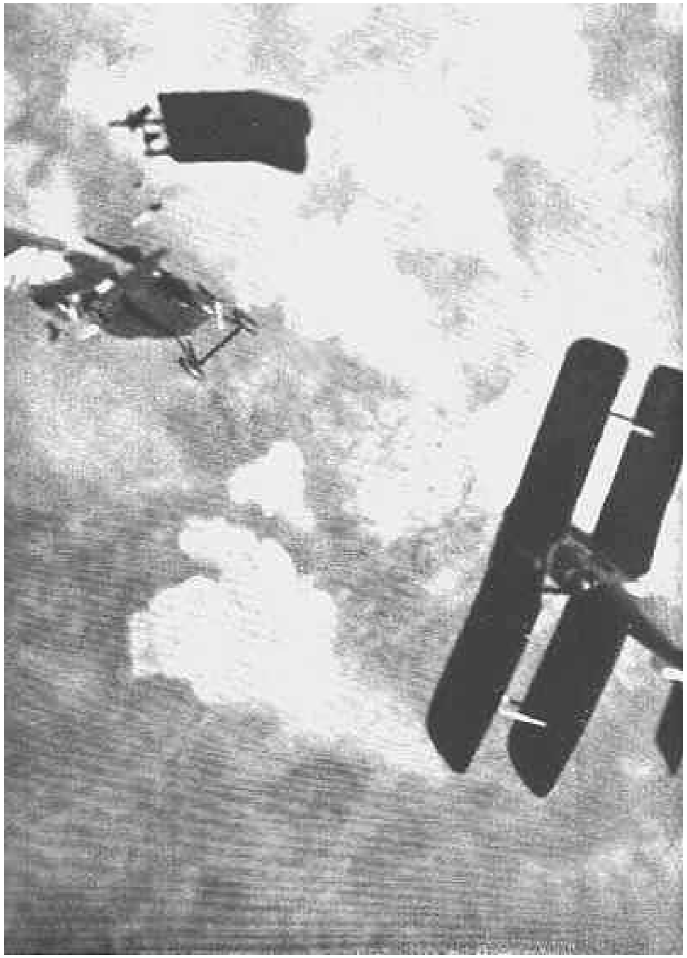




Filling The Water Jacket



Aircraft and Anti-Aircraft Maxims



1917: America Enters World War I

Americans & The Chauchat Machinegun

Hotchkiss 8mm M1914 Machinegun

Browning M1917 Machinegun

1917-18: American Machinegun Production

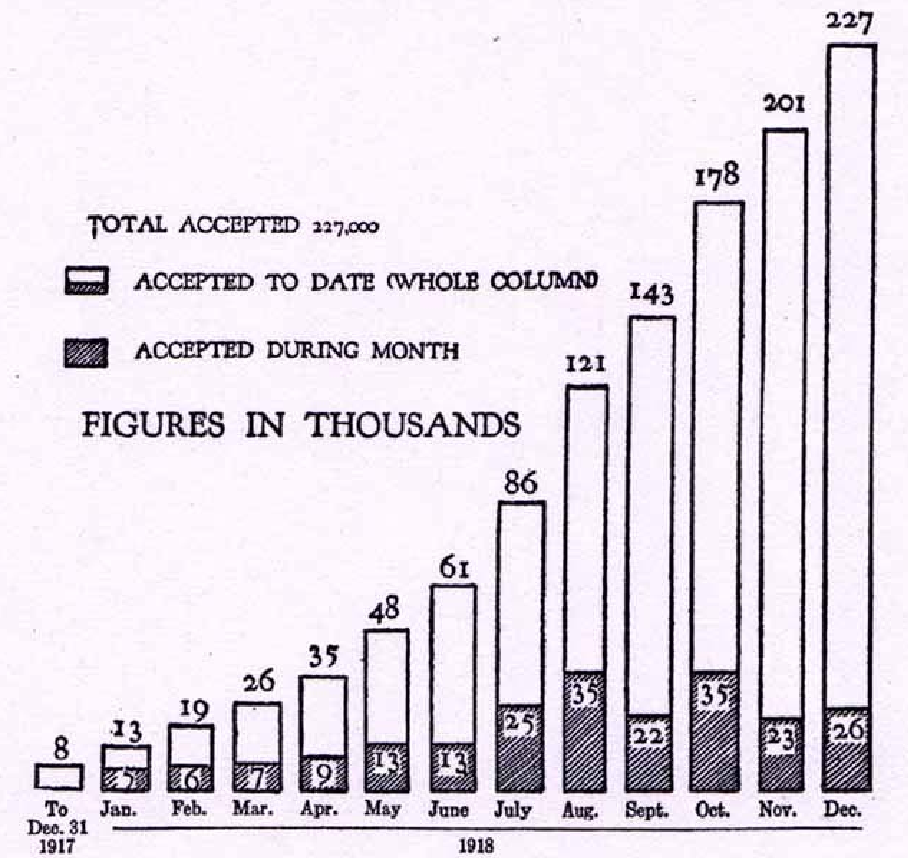


Diagram 27.—Thousands of American machine guns produced to the end of each month.

The Human Cost

1916 – The Battle of the Somme

Summary

SHOWING THE GUN TO MY GRANDSON

Questions?

RDECOM

The Ultimate Caliber:

Myth or Reality?

ARMAMENT RESEARCH, DEVELOPMENT & ENGINEERING CENTER
PICATINNY ARSENAL

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Date: ***May 19, 2008***

Presented By: Shawn Spickert-Fulton

Famous Caliber Studies of Years Past

1. *Thompson-LaGarde Pistol Caliber Study*
2. *John Douglas Pedersen's 1924 Caliber Study*
3. *SAW 1972-1974 Caliber Study*
4. *NATO Point Defense Weapon Caliber Study*

Politics Counts

5.56mm? 6.5mm? 6.8mm? 7mm? 7.62mm? 8mm?

What's Most Important? Depends on who you ask…

- Barrier Penetration Potential
- Consistency / Shelf Life
- Cost
- Manufacturability
- Minute of Angle
- Muzzle Flash / Weapon Signature
- Muzzle Velocity
- Recoil
- Safety
- "Stopping Power"
- Versatility
- Weight

What's best? It all depends…

1. Is your target frequently protected or behind barriers? What type? How often?

2. Do you have legal restrictions which prohibit certain designs?

3. What is the range of interest? Are these ranges all equally important?

4. How many missions and weapons is that ammunition expected to service?

5. Are there any cost or manufacturing or environmental constraints?

6. What can't you live without and what do you absolutely have to have?

Jack of all trades… Master of none…

Can't optimize against everything, and for everyone…

1. *One factor may affect many others.*

2. *The influence of each factor on another is not constant.*

3. *What performance sacrifices are you willing to make on the high end to bring up performance on the low end?*

Test Limitations & Results

1. How do you test each factor?
   - Statistical Nature of Ballistics (Performance Bands)
   - The indirectness of tests
   - The complexity of tests

2. How do you convey test results to your customer?
   - The simplicity problem
   - The time problem
   - The preconceived notion problem
   - The “not invented here” problem

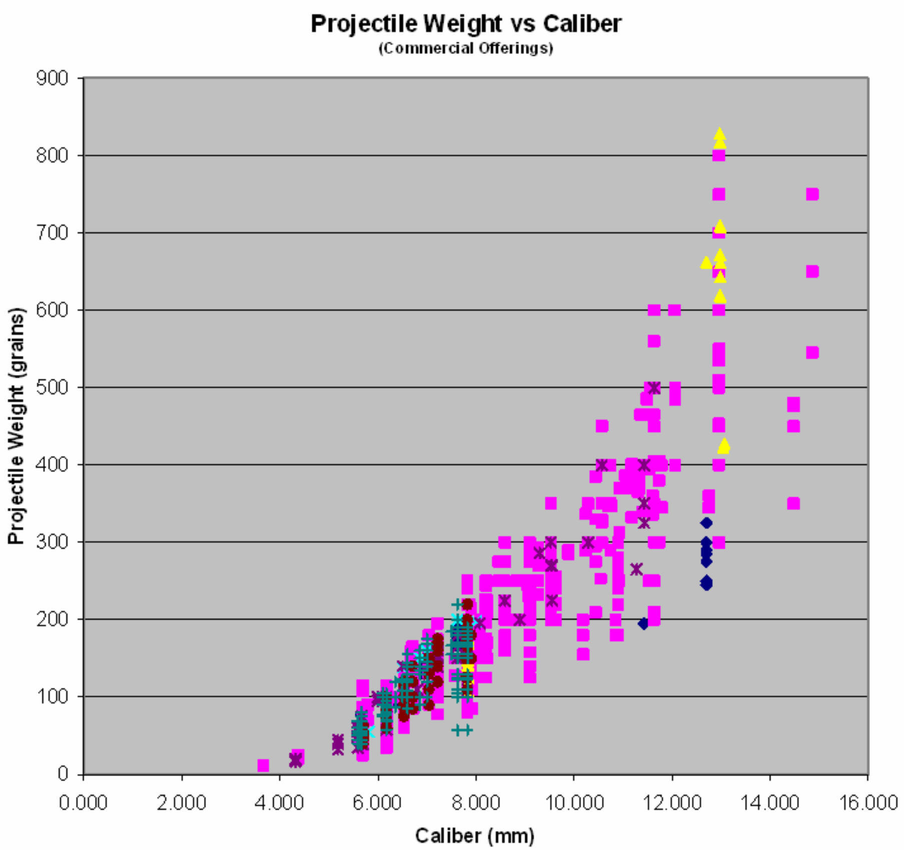
“The problem with small arms isn’t that there aren’t experts. The problem is that everyone is an expert.”

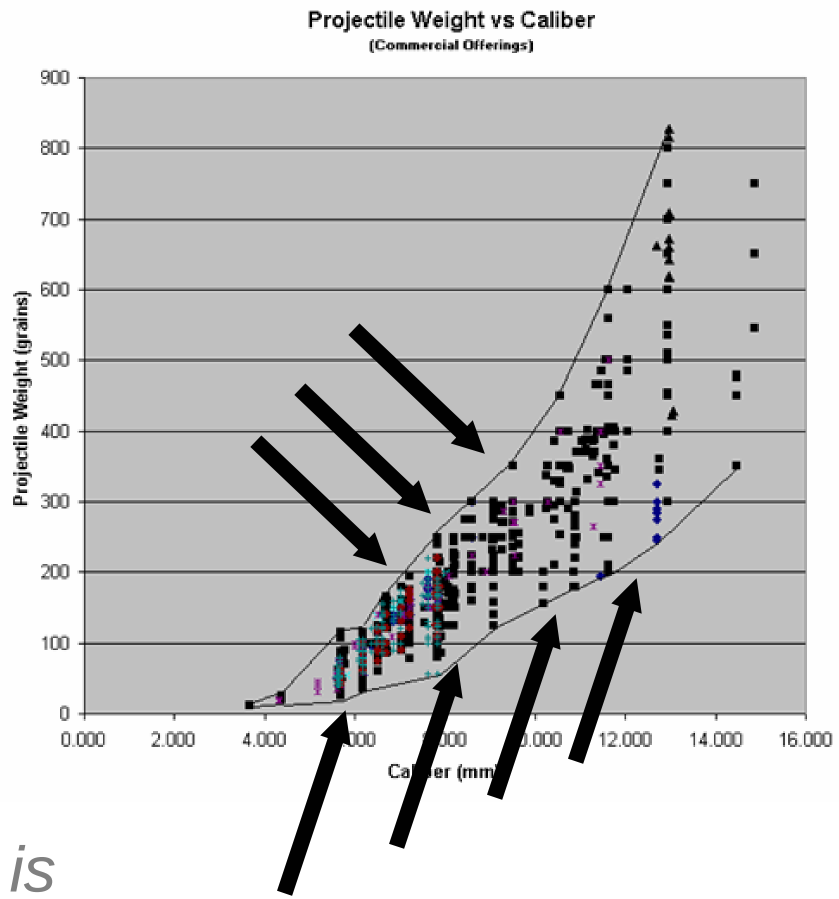
More Food for thought…

- From historical observations, most encounters happen at 100m or less. The ammunition expenditure per casualty ratio for these conflicts is usually hundreds or thousands to one.
- The average engagement range of an encounter is highly dependent upon the weather, terrain, and light conditions of that setting.
- Target exposure time is usually mere seconds. In many instances, they are going to ground by the time they are observed. They may be protected by high, low, or no tech.
- We don't know where the next war will be fought, and we must be prepared to fight in multiple settings at the same time.
- Soldiers must be comfortable, proficient, and confident with their weapons. Multiple weapons for individual settings is not considered optimal. However, specific weapons are not expected to be employed at every operational range.

"Fight as you train. Train as you fight."

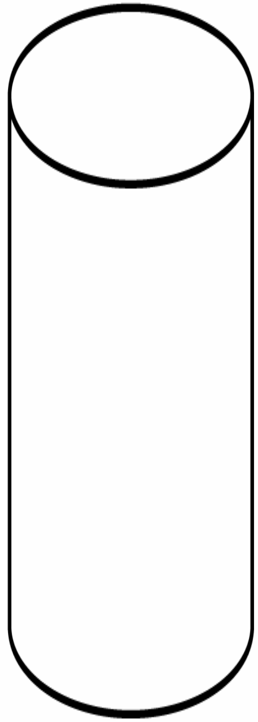
What's Out there?
The Commercial Projectile Weight Envelope





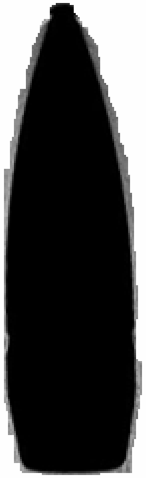
Anything in between the arrows is probable.

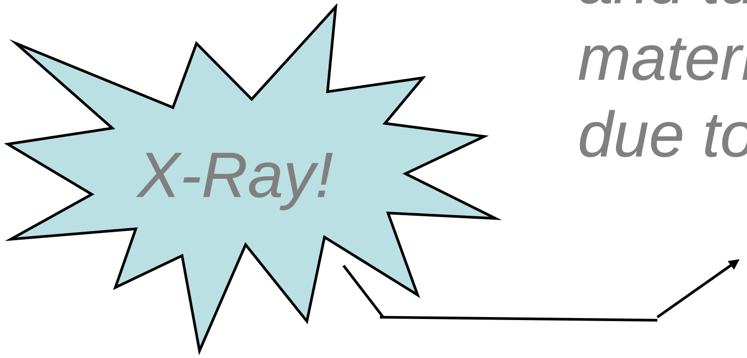
Why the range?



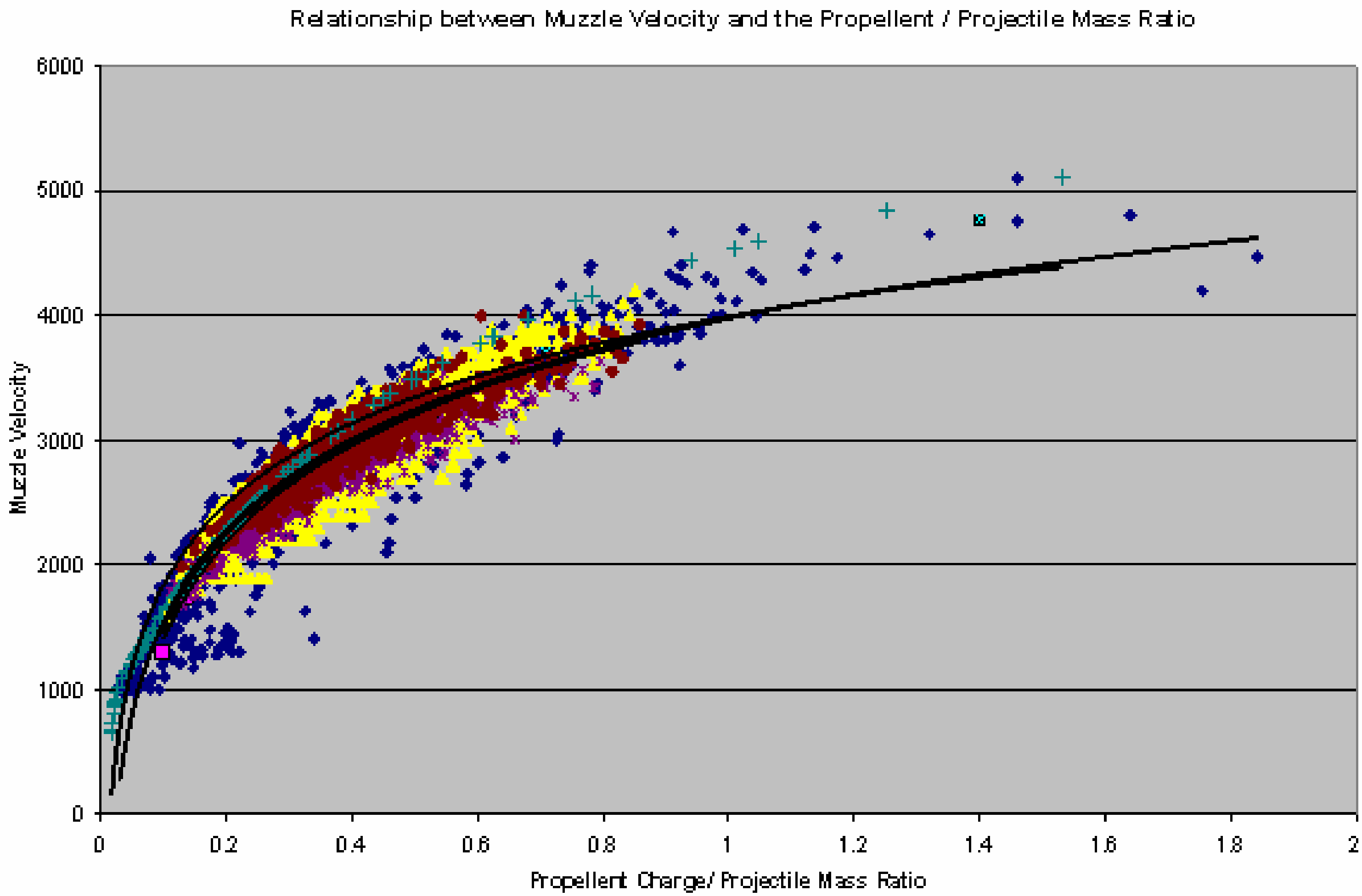
1. *Projectiles have a relatively small range of length to diameter ratios that have desirable flight characteristics.*

2. *The bulk of projectiles are usually composed of materials with a density between steel and tungsten. Lower density materials are used sparingly due to various constraints*





Relationship between Propellant Wt, Projectile Wt, and Muzzle Velocity



Why this Range?

1. Shooters can only adjust for a certain level of launch recoil. (accuracy)

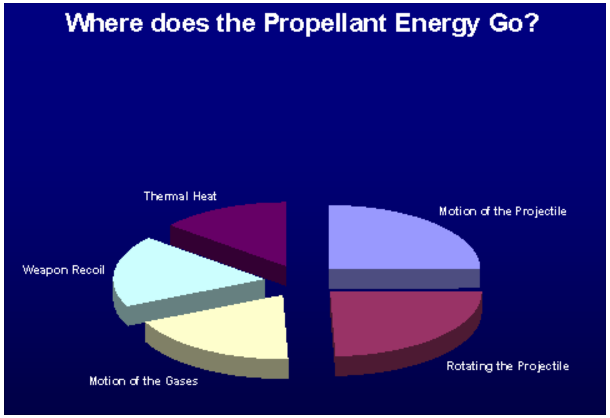
2. Shooters don't want long barrels, but long barrels are required to obtain the upper range of muzzle velocity.

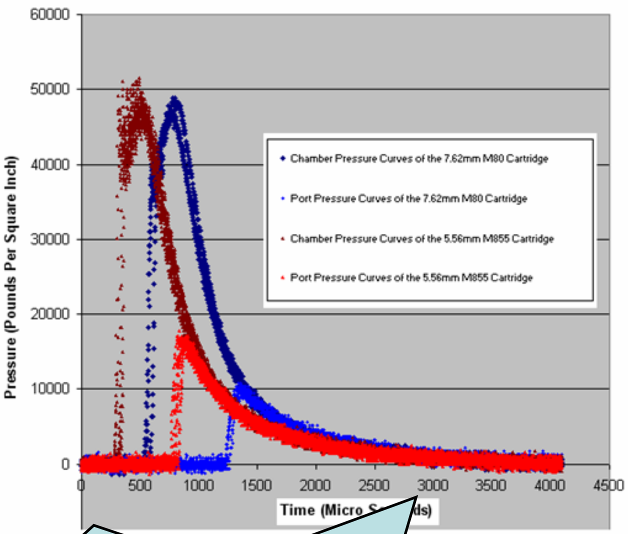
3. Pressure constraints limit overall chamber pressures and projectile velocities

4. Propellant gas physics puts an upper constraint on projectile velocities.

5. Cartridges are used in multiple weapons with different constraints (e.g. M4-10 inch barrel and SAW)

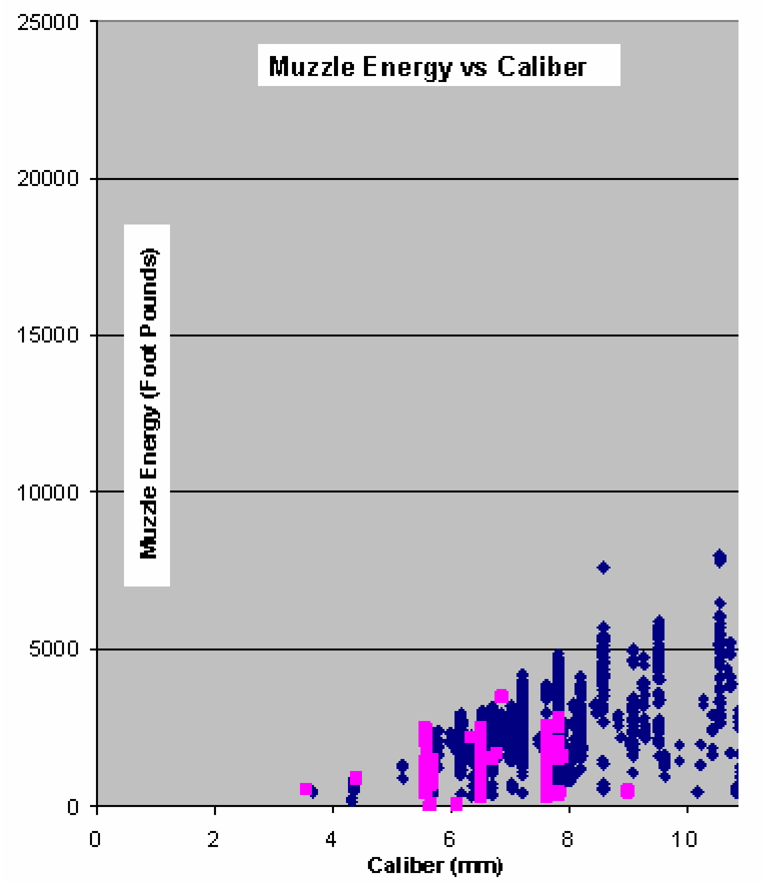
6. Cartridge Volumes





High pressures at muzzle exit result in muzzle flash!

Muzzle Energy vs. Caliber

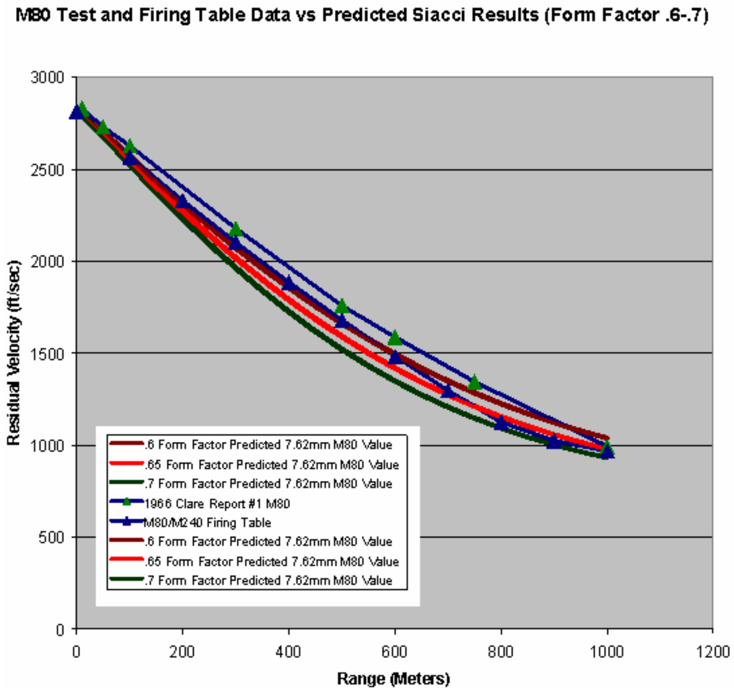


1. Again wide range of values.
2. Depends upon the constraints of the system in question
3. No one answer per caliber.

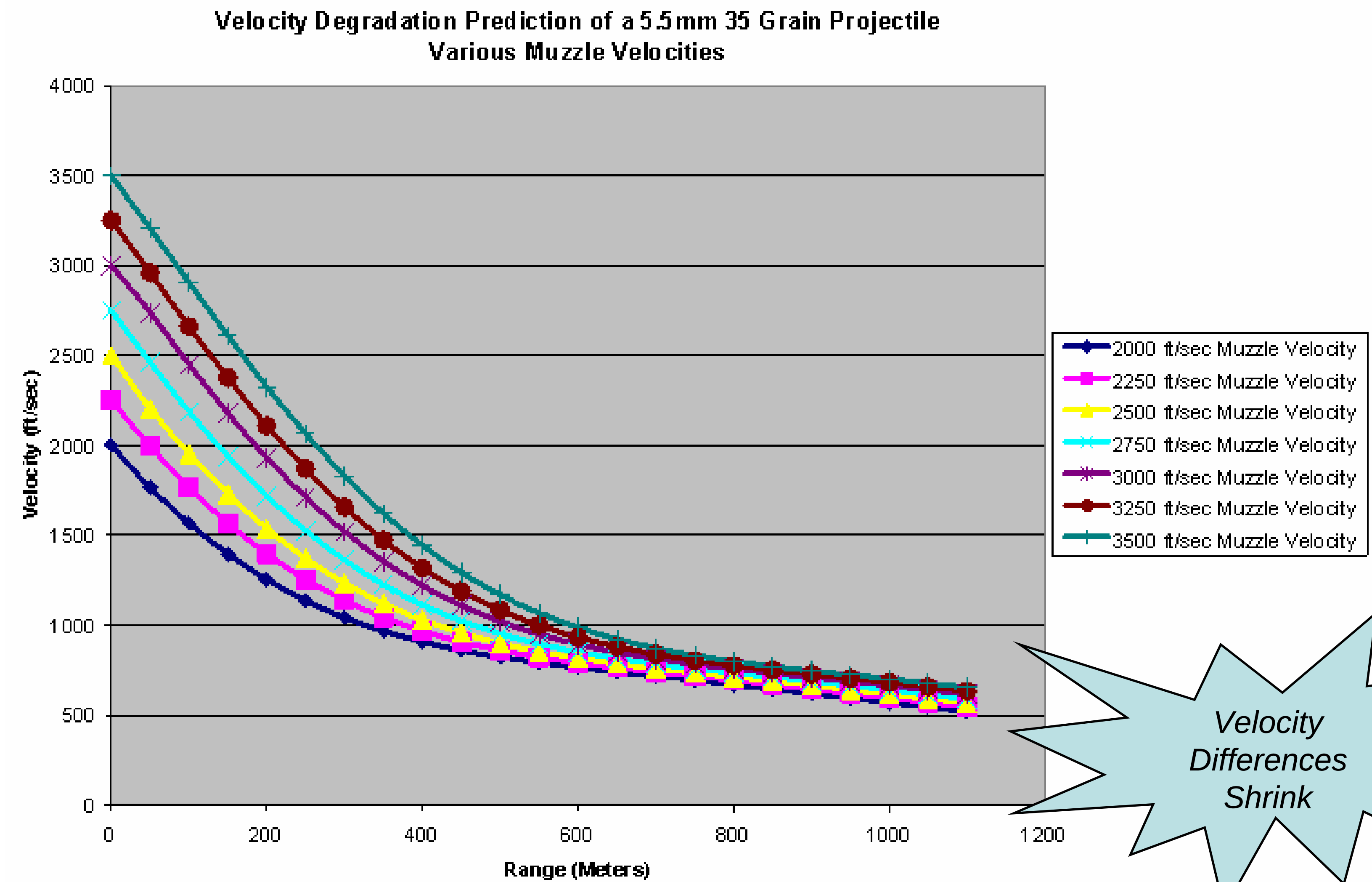
Shape does matter.

- In the next few slides you will see some residual velocity curves that were generated using the Siacci method. This is a theoretical approximation for example purposes.

- The curves reflect shapes that are not atypical of military projectiles. However, drag is a complicated area, and specifics will vary.

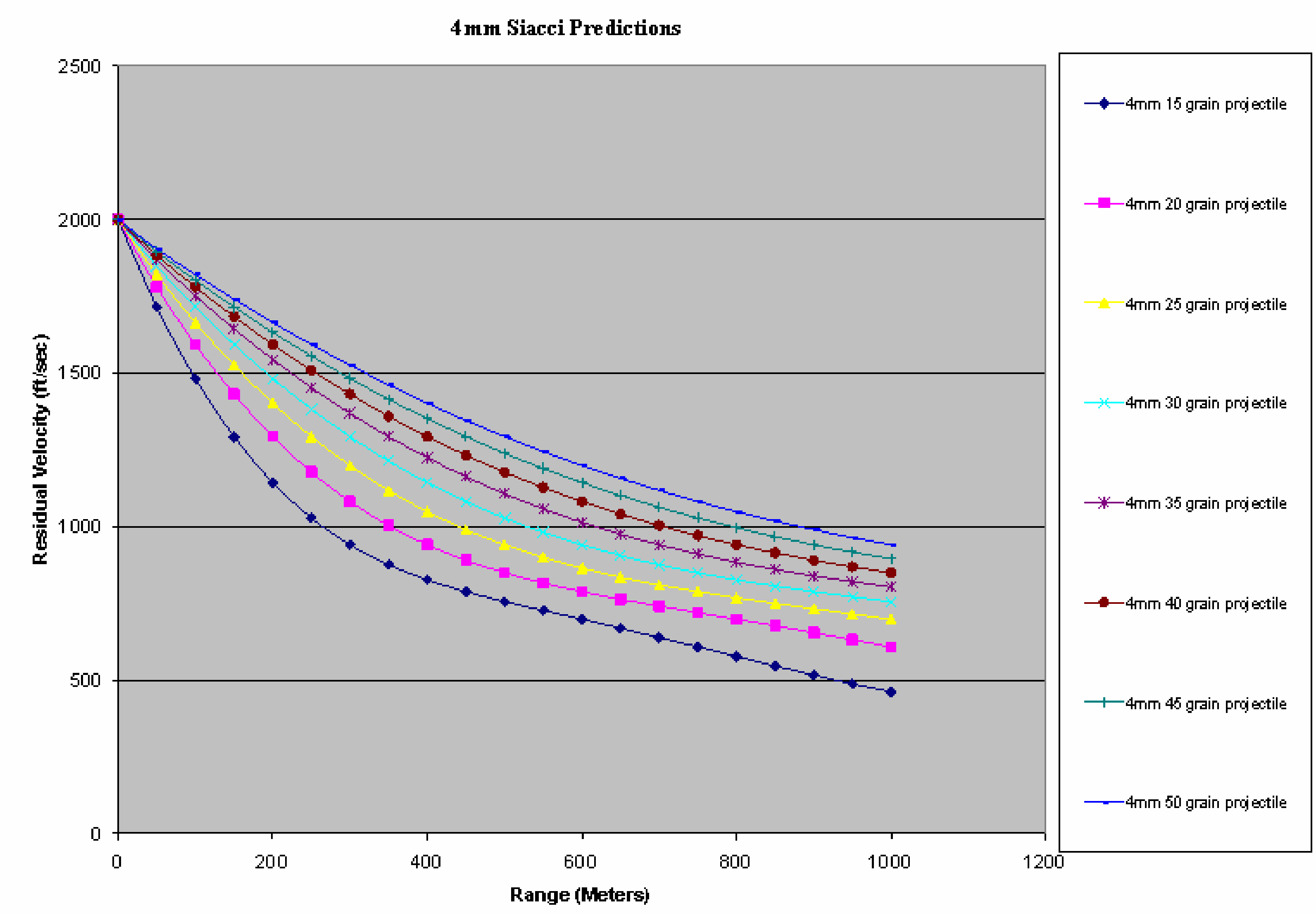


Residual Velocity at Range & Muzzle Velocity

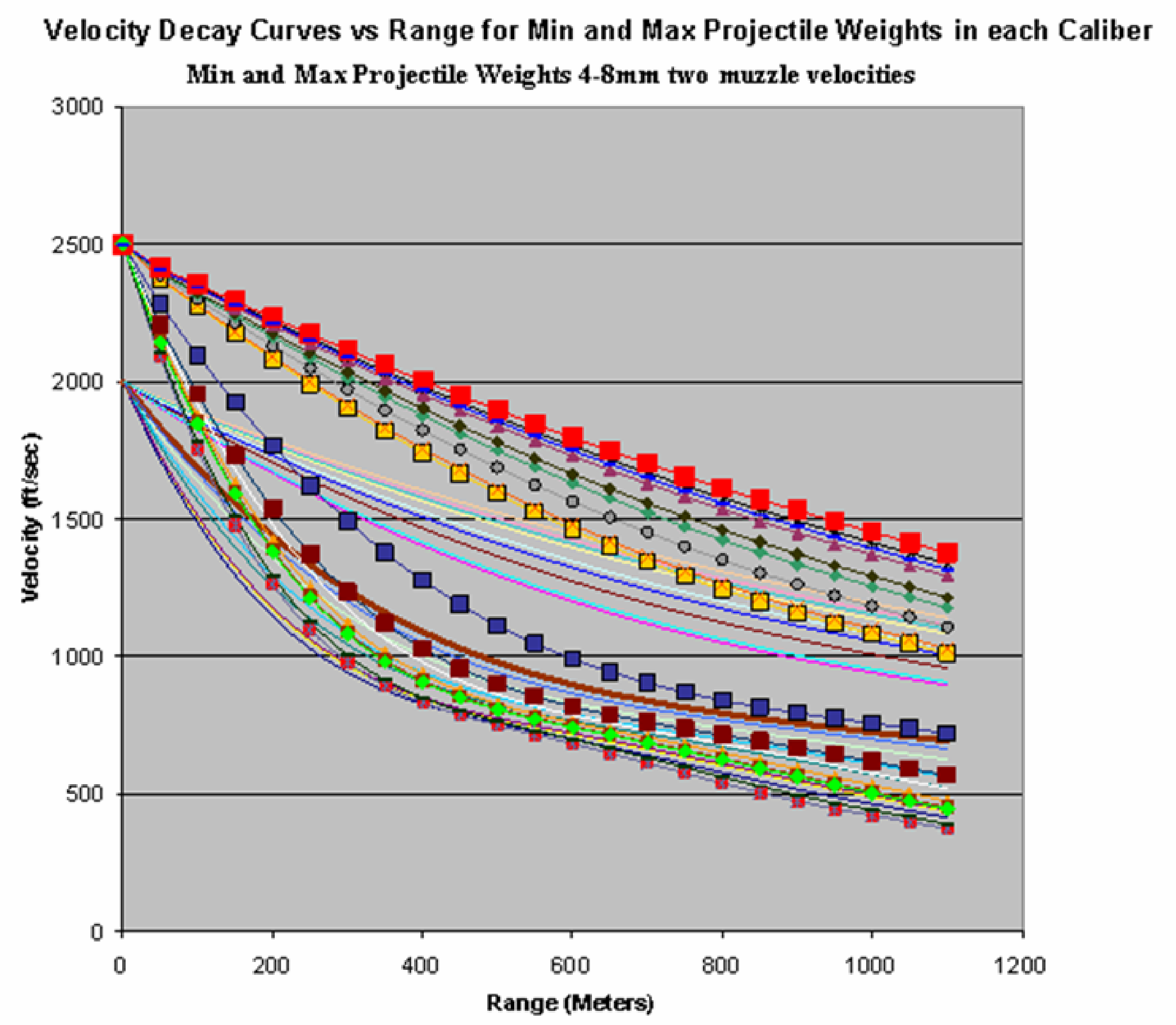


Velocity Differences Shrink

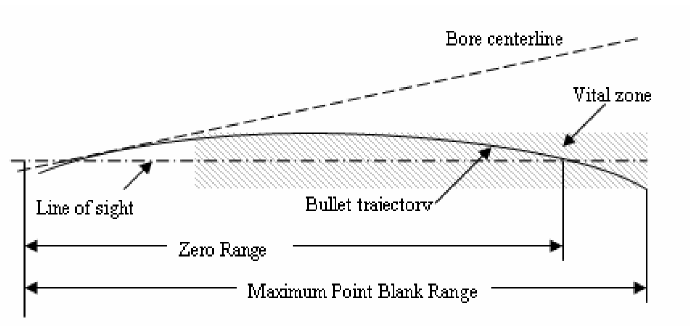
Residual Velocity at Range and Projectile Mass



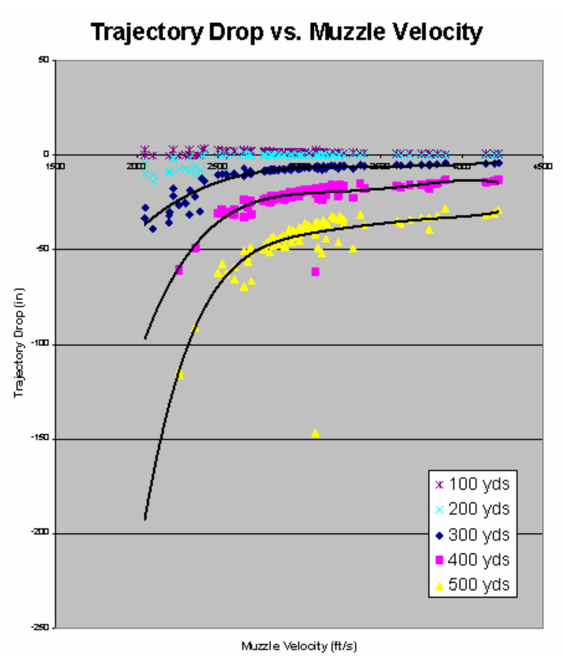
Two sets of curves…

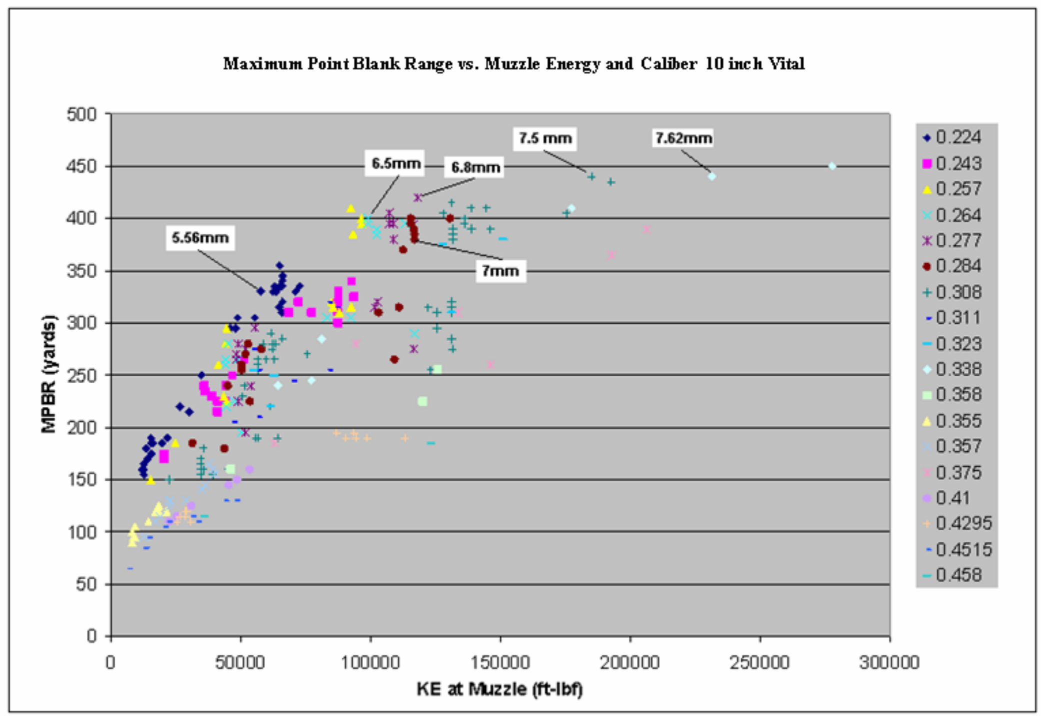


Max Point Blank Range, Precision & Caliber

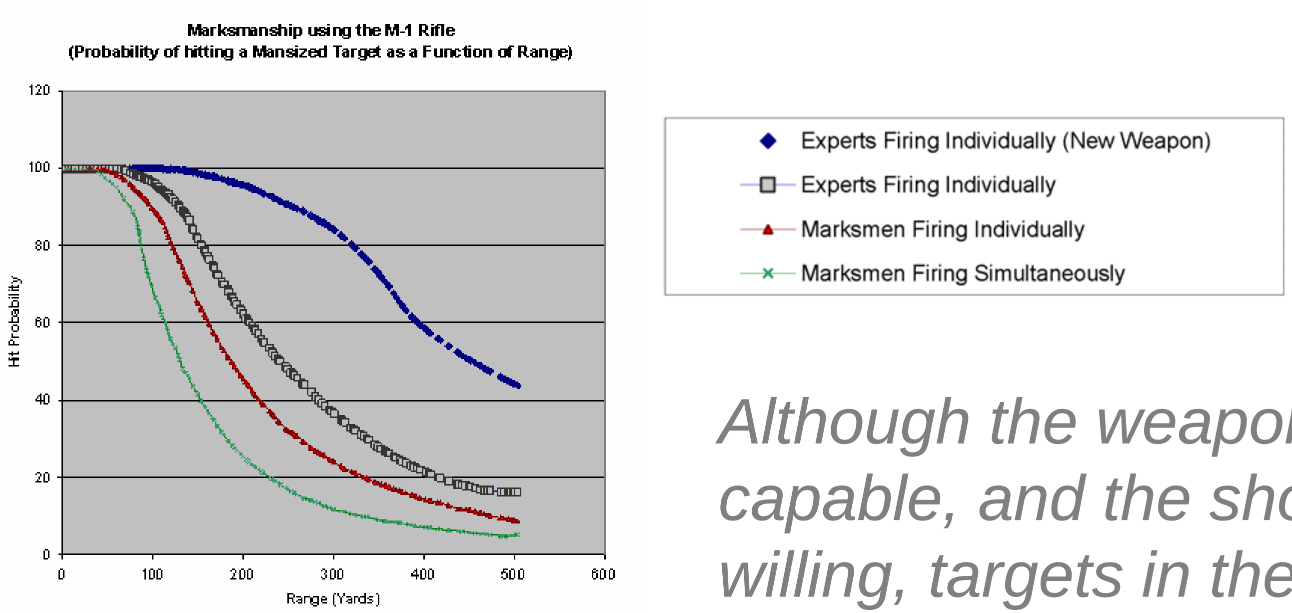


Projectiles should be "zeroed" for as great a span of ranges as possible without readjustment of the sights.

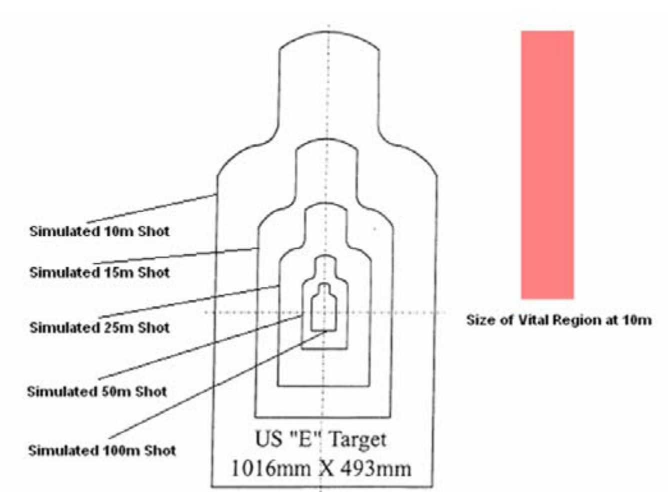




The Rest of the Story…
Precision vs. Accuracy



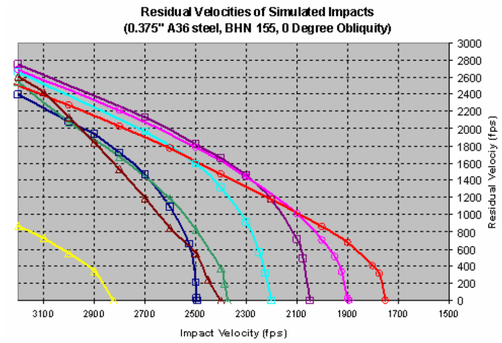
Although the weapons may be capable, and the shooters may be willing, targets in theatre are not hit as often as one would like.

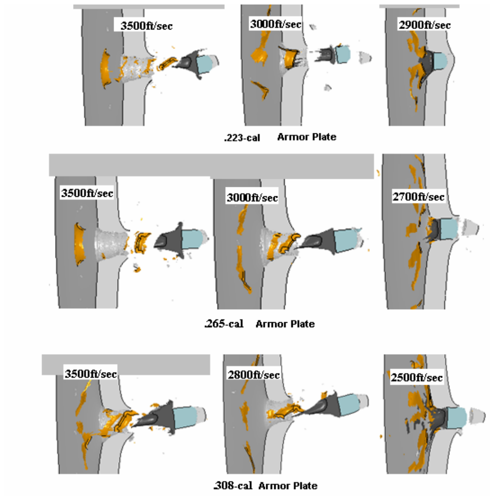


Recoil, Time to Acquire, Stress, and Target exposure time all play a part in limiting the accuracy of the weapon in field scenarios

Getting to the Target…

- Many intermediate barriers on the typical battlefield.
- The -- after barrier effectiveness -- of many projectiles is often of prime importance.
- Projectile penetration effectiveness is tied to the physical characteristics of the projectile, the target, and the impact particulars.

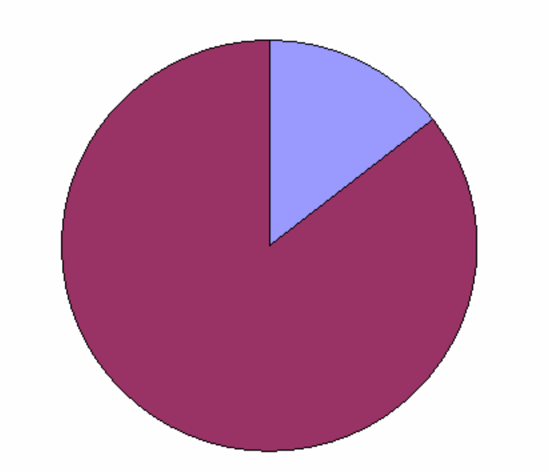


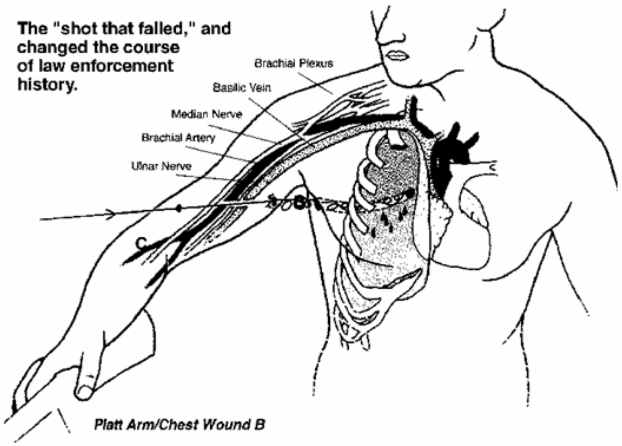


Barrier penetration in many instances is tied to caliber, impact velocity, hardness, density, mass, thickness, angle of attack, obliquity and overall geometry

A look at Incapacitation

Relative Proportion of Vital Regions to Total Target Area (Frontal Target)

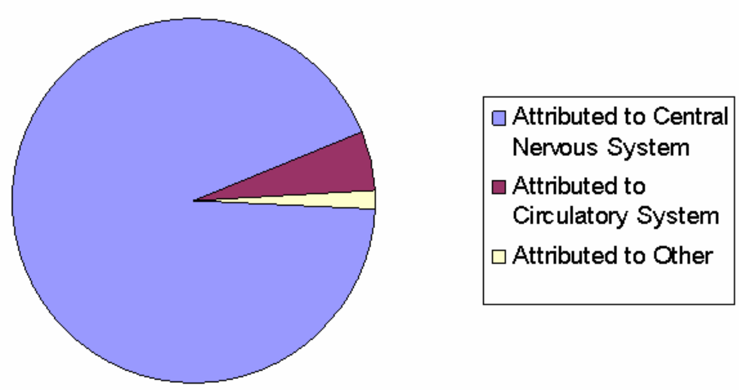




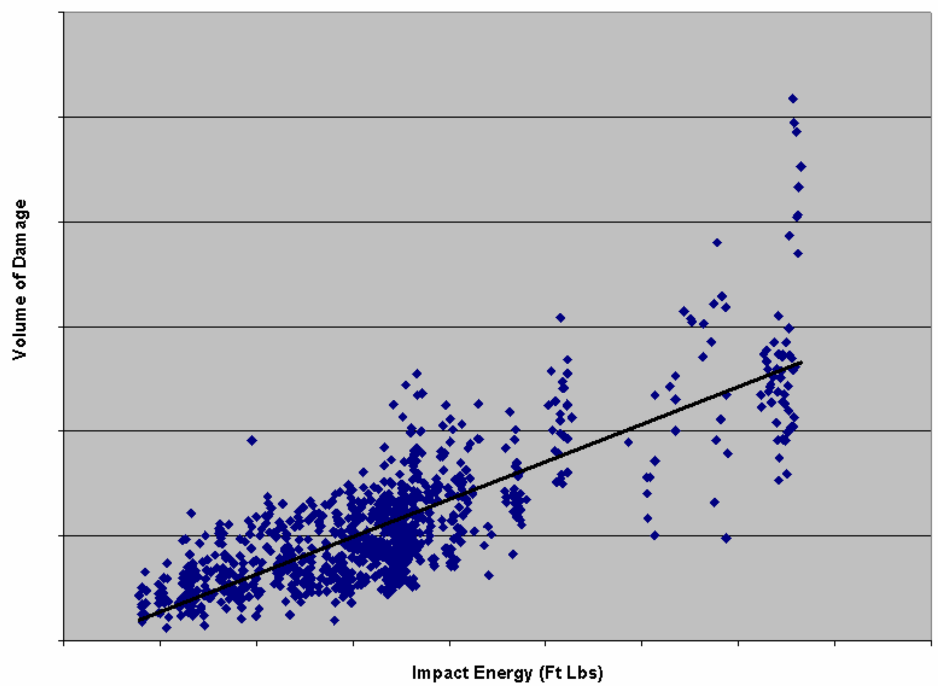
"Not all impacts are equal."

Psychology plays a role in many instances of "instant incapacitation".

Breakdown of Shots Achieving "Instant" Incapacitation



Effectiveness varies considerably (even within a caliber)

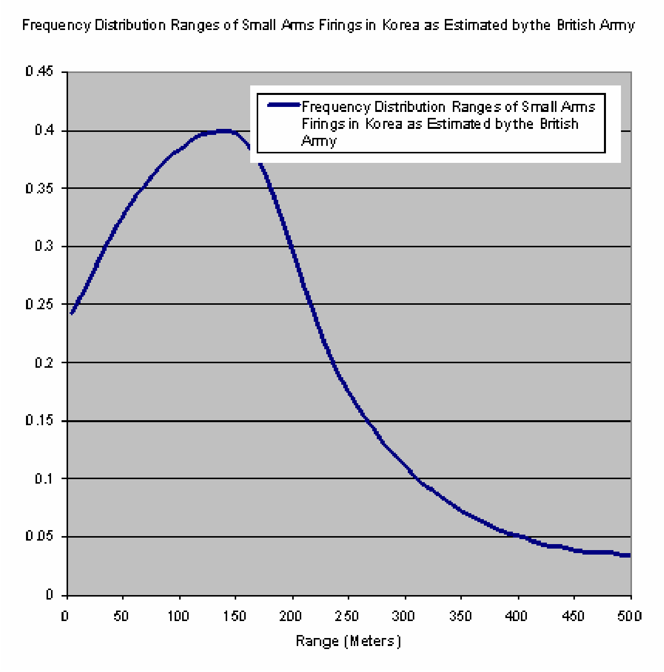


Author	Metric of Performance	Year
Benton[99]	Full penetration of sheets of fir wood	1867
Rhone	Impact KE: 58 Foot-Pound Rule	1896
Zuckerman[100]	$(mass^{.04})*(velocity)$	1942
Callendar	$(mass)*(velocity)^3$	1942
Gurney	$(mass)*(velocity)^3$	1944
McMillan & Gregg	250 ft/sec Impact Velocity in Vulnerable area	1945
Allen & Sperrazza	function of $(mass)*(velocity^{3/2})$	1956
Dziemian	Energy Deposited in 15 cm	1960
Sturdivan	Energy Deposit adjusted by Depth	1975
Bruchey	Semi-Empirical Virtual Assessment	1979

- *Impact energy is like a budget. If your budget is large, there is a lot that you can, but not necessarily will, do. If it is small your choices are limited.*

Yaw at impact, projectile shape, and projectile ruggedness all contribute to how effective a particular projectile/fragment spends its budget after impact. Very difficult to gauge and very controversial

Putting it all together….



Beyond basic performance analysis lies the difficult task of putting it all together.

The expected frequency and importance of different events will largely guide the analyst towards his final answer.

Mathematical weighting plays a significant and controversial role here.

RDECOM

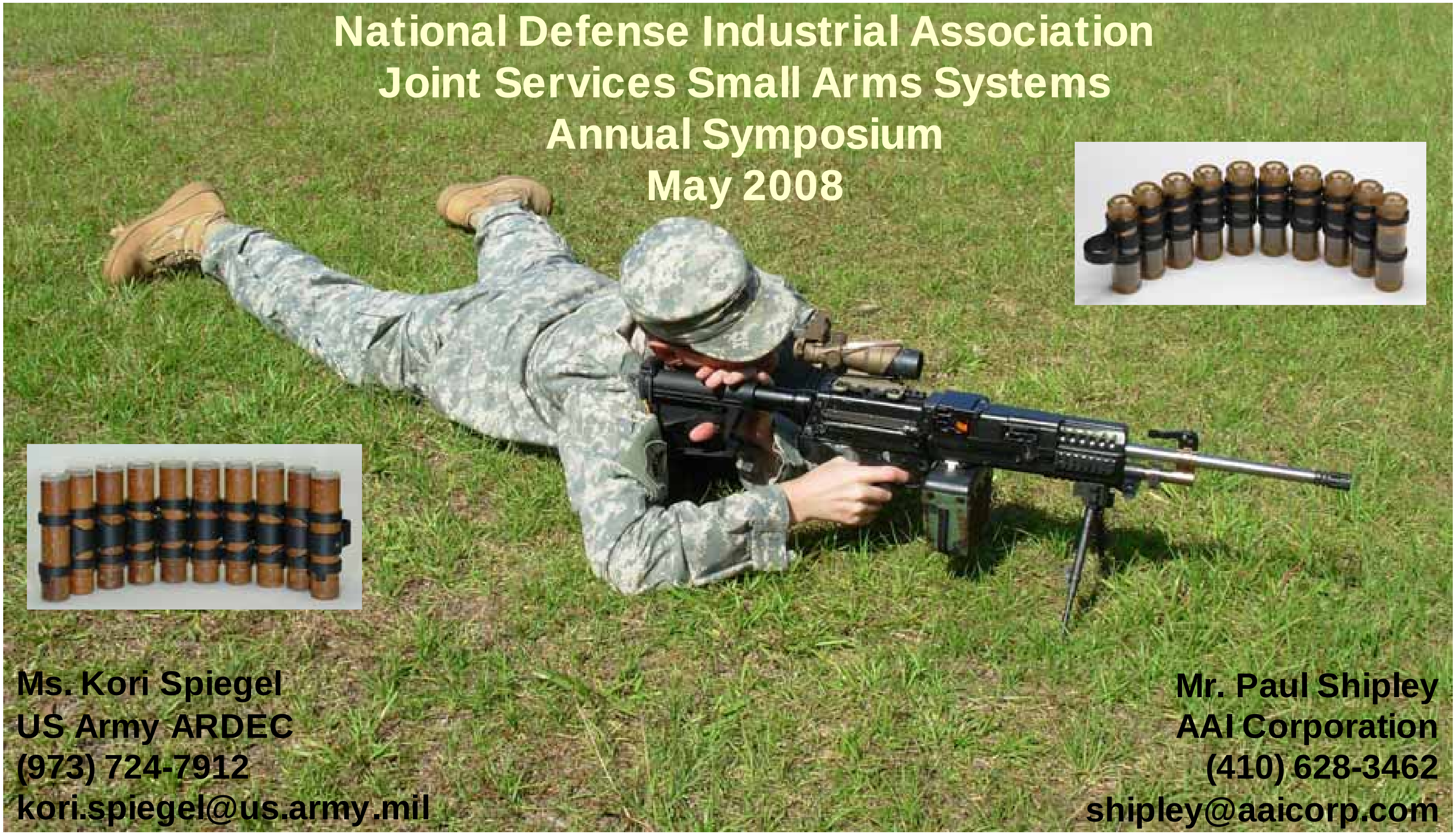
The Reality

- Best caliber evaluations are closely tied to the requirements.
- Several configurations will generally be capable of meeting generalized performance criteria.
- Larger calibers typically:
  - Weigh more
  - Bring more energy to distant targets
  - are more effective against barriers.
  - are less accurate.
- Smaller calibers typically:
  - weigh less
  - bring very high energies to targets at short ranges
  - are effective against many intermediate barriers
  - are more accurate

Historical Footnote

Most historical rifle caliber studies have yielded an optimal value between 6.5mm and 7mm

Lightweight Small Arms Technologies



National Defense Industrial Association
Joint Services Small Arms Systems
Annual Symposium
May 2008

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Lightweight Small Arms Technologies
Top 5 Soldier Weight Contributors

For Automatic Rifleman:

1. M249 Squad Automatic Weapon w/200 rds Ammo
2. 5.56mm Ammunition (400 rounds)
3. Body Armor & Helmet
4. Communication Equipment
5. Canteen/Water

Lightweight Small Arms Technologies
Goals

Lightweight Small Arms Technologies (LSAT)

Goals:

- 35% weapon weight reduction
- 40% ammunition weight reduction
- Reduced training & maintenance
- Maintain cost of current systems

Approach:

- "Clean Slate" design
- Reduced weight as the priority
- In depth trade studies
- Extensive modeling & simulation

Lightweight Small Arms Technologies
Program Approach

5.56mm Telescoped Ammunition

Cased

Caseless

- Focus is development of technologies- not specific weapon system
- Demo via Light Machine Gun with 5.56mm ammunition
- Spiral development approach

Light Machine Gun Demonstrator

- Achieve 50% overall weight reduction
- Pursue parallel Cased Telescoped and Caseless Ammunition design approaches
- High commonality of design and function, some action component differences

Lightweight Small Arms Technologies

Status vs Goals

Capability	Current (M249)	Current LSAT Program		
		Threshold	Current Status	Objective
Weapon Weight	17.5 lbs	13.1 lbs (25%)	CT 9.8 lbs (44%) CL 9.9 lbs (43%)	11.4 lbs (35%)
Ammo Weight 600 rds Pkgd	20.4 lbs	15.3 lbs (25%)	CT(2) 13.6 lbs (33%) CT(3) 12.2 lbs (40%) CL 9.8 lbs (51%)	12.2lbs (40%)
Affordability	Gun $3600 Ammo $262	Gun $3600 Ammo $262	Equivalent	Gun $3600 Ammo $262
TRL	N/A	5	CT TRL 5 CL TRL 4	5
Effectiveness	Baseline	Maintain Baseline	Potential Improvement	Improve Baseline

Lightweight Small Arms Technologies
AAI Contractor Team Members

Lightweight Small Arms Technologies (LSAT)

AAI TEXTRON Systems

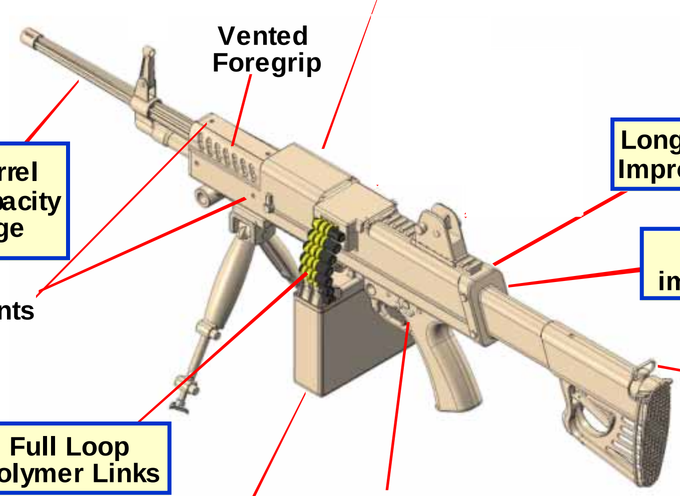
- ARES, Inc.
- ATK
  Launch Systems
  Lake City
- Battelle The Business of Innovation
- St. Marks Powder A GENERAL DYNAMICS COMPANY
- OMEGA TRAINING GROUP, INC.
- **TBD**
  Weapon Producer
- VERITAY TECHNOLOGY, INC.
- MSC Software
- PTi

Lightweight Small Arms Technologies
Weapon Design and Performance Features

Lightweight Small Arms Technologies (LSAT)

Key Technologies

- Use of telescoped ammo-cased and caseless
- Lightweight materials & structural configuration
- Thermal management for weight reduction
  - Barrel
  - Caseless chamber components
- Caseless chamber sealing
- Human factors- firing controllability
- Integration of electronics



Lightweight Small Arms Technologies
Ammunition Design Features

Lightweight Small Arms Technologies (LSAT)

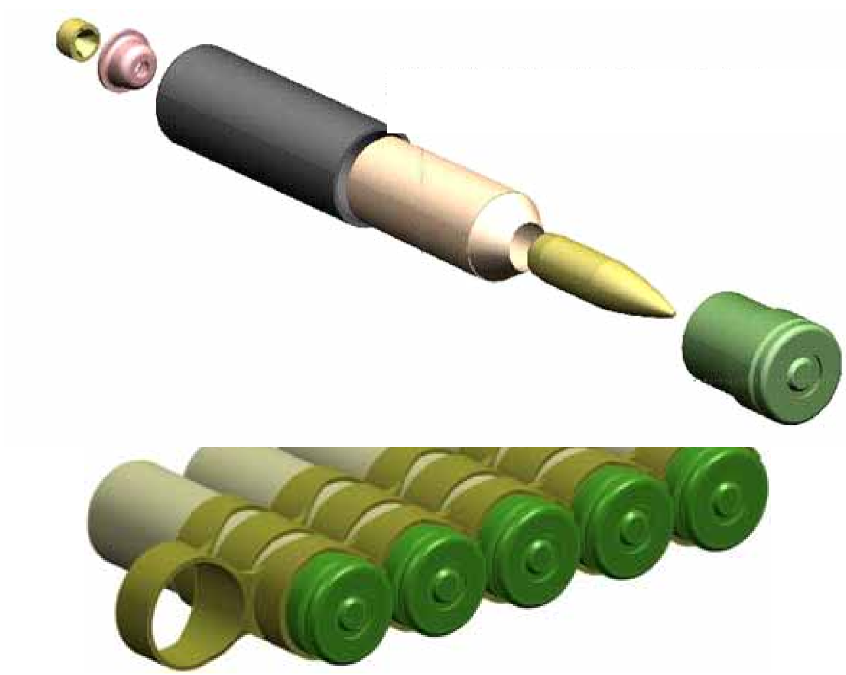
	M855	LSAT CT	LSAT CL
Weight 600 linked pkg'd rnds	20.8 lbs	13.6 lbs (Sp2) *33% reduction* 12.2 lbs (Sp3) *40% reduction*	9.8 lbs 51 *% reduction*
Muzzle velocity (78 ft)	3,020 ft/sec	3,020 ft/sec	3,020 ft/sec
Length	2.25 inches	1.6 inches	1.6 inches
Diameter	0.38 inches	0.45 in (Sp2) 0.38 in (Sp3)	0.35 inches
Primer	Percussion	Percussion	Percussion

Key Technologies

- Telescoped cartridge
- Cased Ammunition
  - Polymer cartridge case and endcap
  - Compacted/consolidated propellant
- Caseless Ammunition
  - High Ignition Temperature Propellant
  - Booster assisted interior ballistics
- Demonstrate in 5.56mm
  - Address producibility
  - Consider scalability

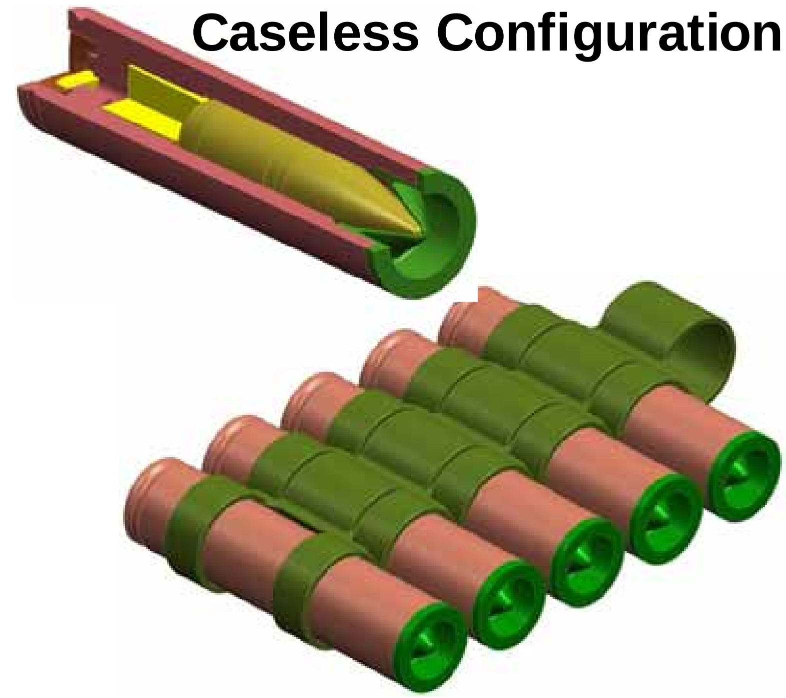
Lightweight Small Arms Technologies
Ammunition Features

Lightweight Small Arms Technologies (LSAT)



- Conventional technology in telescoped configuration
- 30 – 40% weight reduction
- Lower Risk

Caseless Configuration



- High Ignition Temperature Propellant Technology
- 50%+ Weight Reduction
- 40% Volume Reduction
- Higher Risk

Cased Telescoped System

Design and Development Status

- Ammunition -

- Weapon -

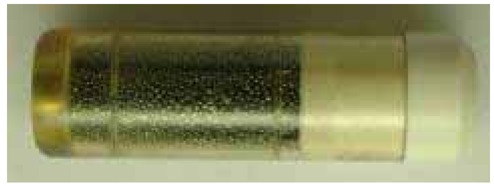
CT Ammunition Chronology

2005

Spiral 1 Cartridge

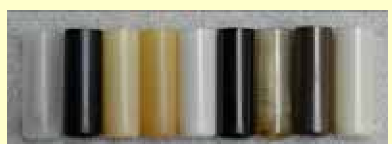
- 24% wt red, 0.50” OD
- Off the shelf propellant
- Demonstrated concept and performance
- Used for initial weapon development testing and cartridge geometry studies

2006

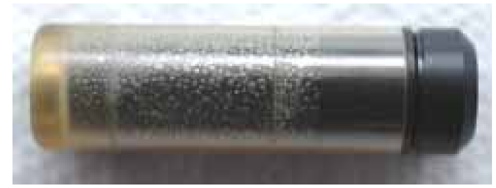


Spiral 2 Cartridge

- Reduced size, weight
- Custom LSAT powder w/reduced flash
- Material optimization across temperatures
- Supported integrated weapon development



2007 (May)



Spiral 2 Cartridge

- 33% wt red, 0.46” OD
- Continued refinements
- Baseline established for materials, design, tooling
- Supported weapon development, demos

Spiral 3 Cartridge

- Initiated development

CT Ammunition 2007/08 Update

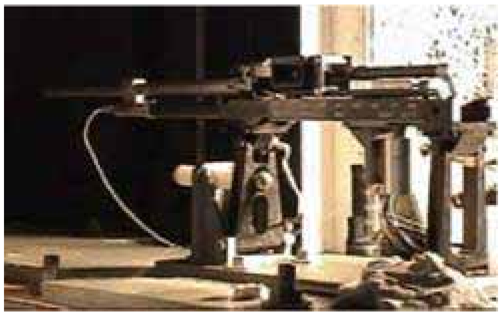
Lightweight Small Arms Technologies (LSAT)

- ***Spiral 2- Fabricated ammunition to support weapon testing***
- ***Spiral 3- Conducted initial performance testing***
  - Compacted propellant
  - Consolidated propellant
  - 0.38” diameter
  - 40% Weight Reduction
- ***Over 9,000 rounds fired***
  - Mann Barrels and Machineguns
  - Temperatures ranging from -65F to +160F
- ***Preparing 2,000 rd contract delivery***

CT Spiral 1 | **CT Spiral 2** | **CT Spiral 3** | **CL Spiral 2**

CT Weapon Chronology

2005



SN 1

- Action function assessed using dynamic test fixture
- Spiral 1 ammo
- Validated kinematic model

Lubricious coating assessment

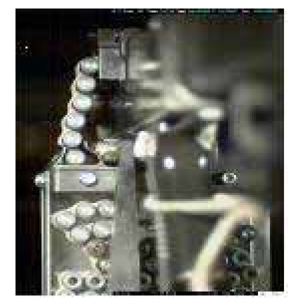
2006

SN 1

- Integrated weapon/action
- Conducted functional assessments, incorporated design refinements
- Fixture and shoulder firings
- TRL 5 demo with Spiral 1 ammo

SN 2

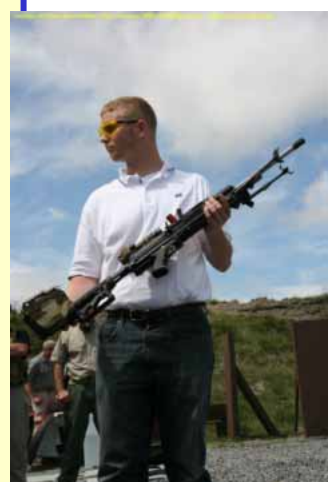
- Initiated design updates
- Fabricated hardware



CT Weapon Chronology

2007 (May)

SN 1



SN 2

SN 1

- Fired approx 3,000 rds
- Converted weapon to Spiral 2 ammo
- Army DTC limited safety release for manned fire
- Conducted shootability assessment
- Confirmed TRL 5 with Spiral 2 ammo

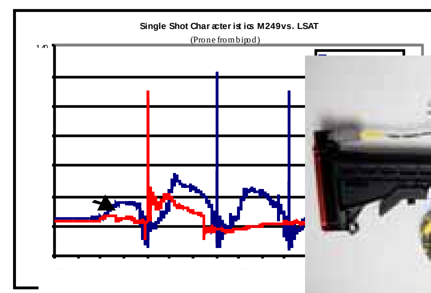
SN 2

- Weapon Action in test, approx 750 rds fired
- Integrated weapon components ready

CT Weapon 2007/08 Update

Lightweight Small Arms Technologies (LSAT)

- *SN1*
  - Fired approx 6,500 total rds
  - Conducted 4 major live fire demos
  - Measured system characteristics
    - Aim disturbance/compensation
    - Recoil
    - Barrel thermal/ablator heat reduction
  - Incorporated design refinements



- *SN2*
  - Fired approx 2,000 rds
  - Integration complete
  - TRL 5 verification underway

Caseless System

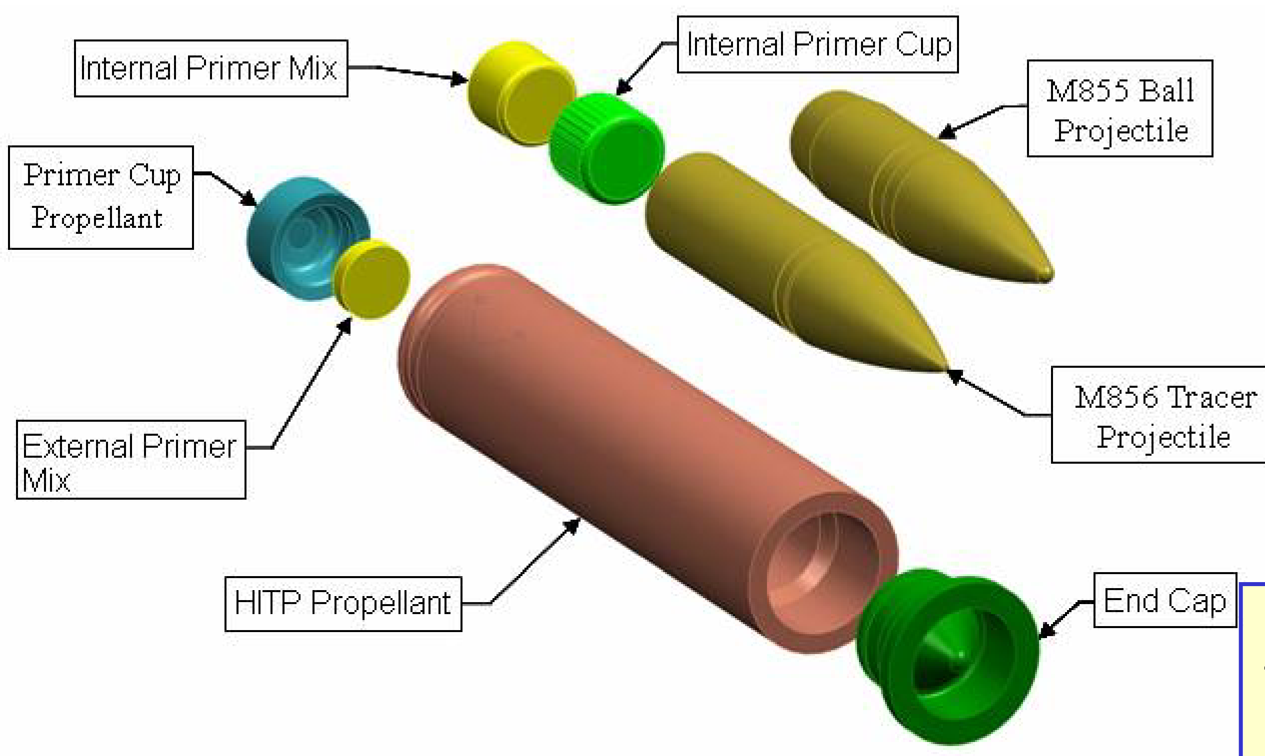
Design and Development Status

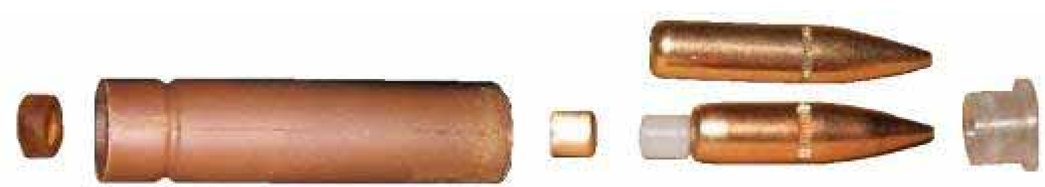
- Ammunition -

- Weapon -

CL Cartridge Components & Technologies

Lightweight Small Arms Technologies (LSAT)





Key Technologies

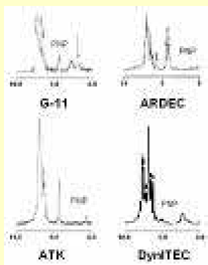
- Telescoped configuration
- High Ignition Temperature Propellant (HITP)
- Internal Primer assisted interior ballistics

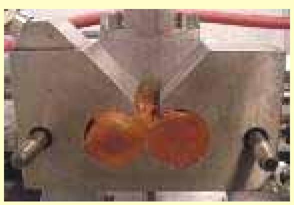
CL Ammunition Chronology

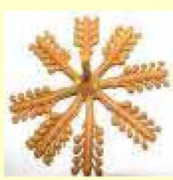
Lightweight Small Arms Technologies (LSAT)

2005 → 2006 → 2007 (May)

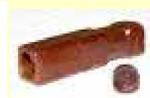
Characterize HITP

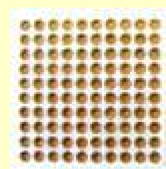


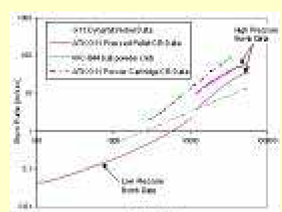




Replicate 4.92mm ACR







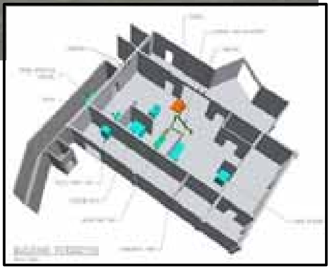
Begin Scale-up to 5.56mm

- Fabricate initial Spiral 1 5.56mm ammo using lab-scale process

- Design and equip process scale-up facility

CL Ammunition 2007/08 Update

- ***Spiral 2 Process scale-up facility complete and in use***
  - Located at ATK Launch Systems (Utah)
  - Equipment includes
    - 50 ton transfer mold
    - Dry material feed and handling
    - Solvent processing
    - Horizontal mixer
  - Several Design-of-Experiments process studies
- ***Dedicated primer fabrication facility nearing completion at ATK Lake City AAP***



Spiral 2

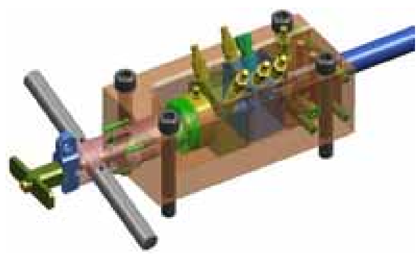
CL Ammunition 2007/08 Update

- ***Refined Spiral 2 Ammunition***
  - Several Design-of-Experiments HITP process studies
  - FNGUN interior ballistics model updated
  - Primer (internal and external) material studies
  - Preparing contract deliverable ammunition
- ***Initiated Spiral 3 Development***
  - Replace energetic binder
    - Improve cost/environmental considerations
    - Reduce production facility impact
  - Reduce thermal load on weapon
    - Burn rate modifiers- reduce flame temperature, improve barrel life
    - Exterior coatings- reduce heat transfer rate

CL Weapon Chronology

Lightweight Small Arms Technologies (LSAT)

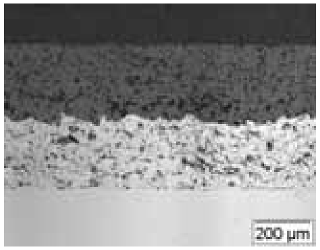
2005

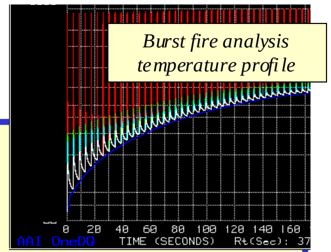


Component Studies

- Chamber sealing
- Firing pin interface
- Characterize thermal loads
- Utilized residual 4.92mm ACR ammo
- Maximize CT commonality

2006

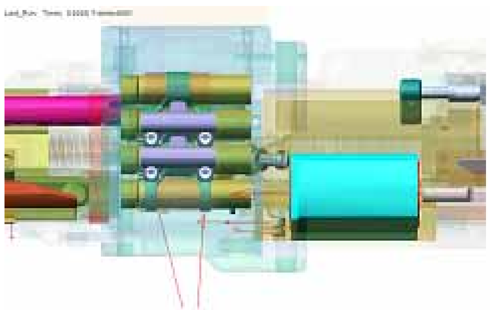


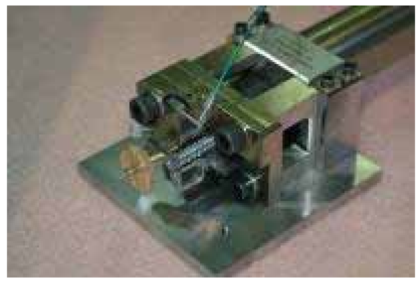
Thermal Focus

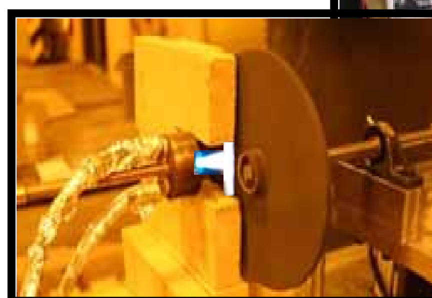
- Initial material studies
  - High temperature
  - High heat capacity
  - Insulating materials
- Thermal configuration studies
- Ablator heat reduction assessment

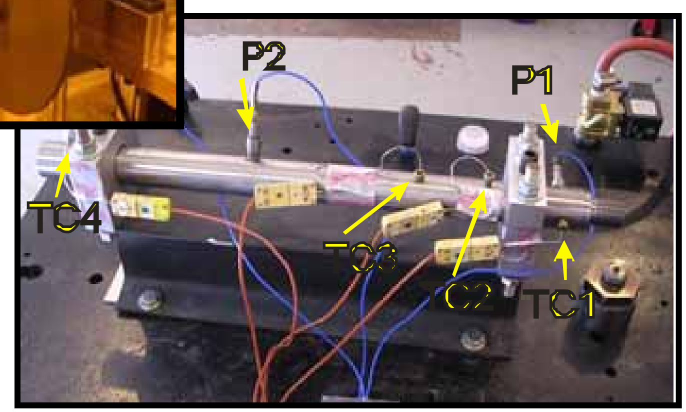
CL Weapon Chronology

2007 (May)









Design Finalization
- 3D models, kinematics
- Subsystem test fixtures

Mat'l Thermal Investigations
- Insulating materials
- Laser pulse heating apparatus
- Ballistic fixture
- Automatic fire barrel heating/model

CL Weapon 2007/08 Update

Lightweight Small Arms Technologies (LSAT)

- ***Conducted Weapon Subsystems Tests***
  - Ballistic interfaces
    - Firing pin
    - Chamber volume
    - Seals

  - Weapon/Cartridge interfaces (via CT wpn)
    - Rammer loads
    - Cross feed loads
    - Free belt dynamics
    - Validated kinematic model

- ***Weapon action tests underway***
- ***Continued thermal tests***
  - Insulating materials

Rifle Design Activity

- *Initiated in 2008*
- *Requirements analysis*
- *Concept development and tradeoffs*
  - Both CT and CL designs (ctg same as LMG)
  - 17 rifle concepts- various mechanisms and overall configurations
  - Two magazine approaches- weapon powered, spring powered. Focused on high capacity.
  - Evaluated, downselected to two each CT and CL
- *Detailed design*
  - Nearing completion
  - Full detail 3D models
  - Structural analysis, kinematic analysis

Ongoing Supportability Activities

- *Supportability Focus*
  - Evaluate technology implementation considerations
  - Fully integrated with development effort
- *Key Activities Nearing Completion*
  - Logistics Support Analysis- Level of Repair analysis (COMPASS), Life Cycle Cost analysis (ACEIT), O&M task identification (new Army maintenance concept)
  - Reliability, Availability, Maintainability- Failure modes, effects, and criticality analysis, reliability tracking, mean time to repair
  - Training analysis and materials- Training concept, training task analysis
  - Human System Integration- Human factors design support, system safety evaluations, fightability assessments (2 complete), shootability assessment (1 complete)

Lightweight Small Arms Technologies
Summary

- System design meets all program requirements:
  - Weight reduction exceeds goals
  - Improves lethality
  - Improves logistics
  - Improves ergonomics
- Maintaining parallel, synergistic Cased Telescoped and Caseless development plan
  - Emphasizes commonality
  - Reduces program risk
  - Initiated Rifle design activity- requirements, concepts, detailed designs
- Scalable design provides significant modularity and commonality
- Cohesive Government/industry team ensures success in development, user acceptance, and production

Comments/Questions?

NAVY SMALL ARMS

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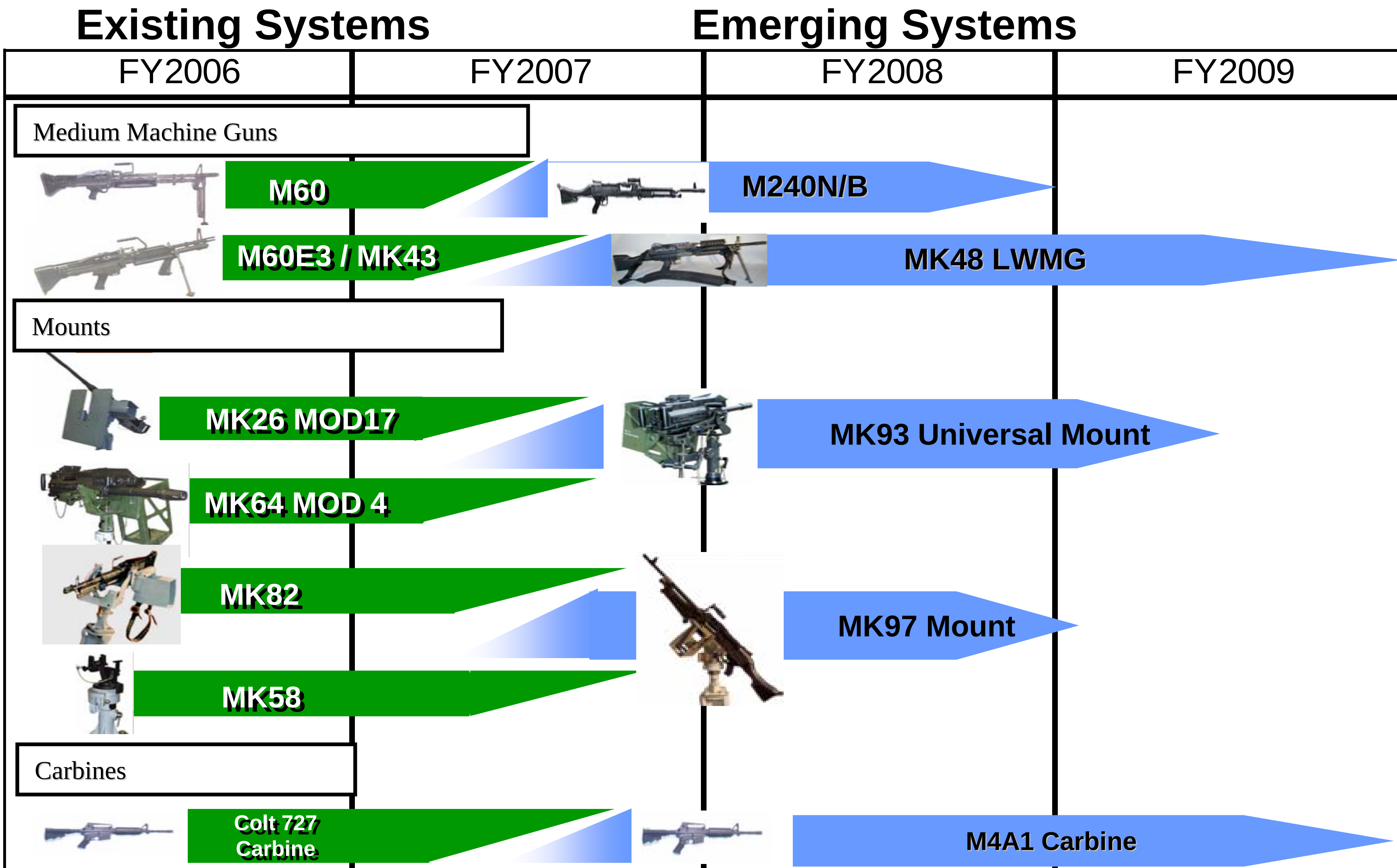
Navy Small Arms Program Overview

- Full life cycle support for the Navy's small arms
  - Engineering
  - Acquisition
  - Maintenance
  - Weapons distribution
  - Weapons Tracking
  - Acquisition and acquisition support are provided for all small arms, mounts and related equipment
    - **Majority of acquisitions are from Army or direct from OEM**
    - **Occasional modifications to in-service weapons/mounts**
    - **1,223 worldwide activities**
    - **Over 422,000 weapons**

Navy Small Arms Program

Road Map

Small Arms
Modernization Way Ahead



Small Arms Modernization Way Ahead (cont.)

Existing Systems

Emerging Systems

FY2006	FY2007	FY2008	FY2009

Rifles


M16A1HB


M16A3/5


M14

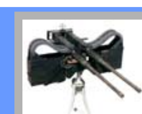
40MM Grenade Launcher


M79


M203

Surface Ship Machine Gun


MK19 GMG


Twin M2HB MG


MK44
Mini Gun


Twin M240 MG

What can industry do for Navy Small Arms?

- Navy Afloat
  - Problem - Harsh sea environment corrodes weapons
  - Need – Improved maritime coatings or materials

  - Problem – Weapons and ammunition are stowed below deck and must be transported top side using ladders, hatches, etc.
  - Need – Lighter, smaller, more compact weapon and ammunition

  - Problem - Weapon round counts are inaccurate
  - Need – Automatic round counters

- Navy Shore Stations
  - Problem – Increased training requirements for crew served weapons
  - Need – Reduced range training ammunition requirements for M240, M2HB, MK19 by using virtual simulators, etc.

  - Problem – Increased security at check points at base entrances and piers.
  - Need – Ability to choose between non-lethal or lethal force, rapid transition from less than lethal to lethal

- Naval Air
  - Problem – Overheating barrels on XM218 / GAU16 Light Weight .50 cal MG barrels
  - Need – Barrels that can be fired maximizing the number of rounds on target per aircraft pass

BACKUP

Small Arms
7.62mm Machine Gun Modernization

- Replace the obsolete M60 Family of Machine Guns (MG)
  - $32.4M FY05 -06 supplemental funds used to procure > 3000 each M240 MG as replacement for the M60 MG
    - Includes mounts, initial issue kits, and spare parts
  - Replacement of M60s with M240B/N was accomplished on a priority basis (CFFC determined priorities).
    - Training Commands
    - Units in direct support of GWOT
    - Deploying Battle Groups
    - Shore stations
    - Remaining Fleet units
  - MK43 and remaining M60E3 Lightweight M60s will be replaced with the MK48 LWMG during FY09. 70% commonality of parts with M240.

Small Arms Mount Modernization

- Replace the MK26 Mod 17 and the MK64 Mod 4 with the less expensive and more robust MK93 universal mount
  - 2000+ MK93 mounts on order. Delivery rate approximately 75 mo
  - Capable of mounting both the M2HB .50 cal and the MK19 40mm Grenade Machine Gun
  - With an adaptor, can also mount M240 7.62mm Medium Machine Gun (this option is too expensive under normal circumstance)
  - Transition to the MK93 mount should be complete by 4Q FY08

- Replace the MK58 and the MK82 M60 Machine Gun mounts with the MK97 M240 Machine Gun mounts
  - MK58 and MK82 specific to the M60 family of Machine Guns
  - MK97 is specifically designed to mount the M240 family of Machine Guns
  - 1200+ MK97 mounts on order. Sufficient mounts on hand/on order to meet all requirements.
  - Transition to the MK97 mount should be complete by 4Q FY08

Small Arms
Rifle Modernization

- Replace the M14 7.62mm As the Fleet's Primary Rifle
  - USN is only user of the M14 rifle
  - Too heavy for use in VBSS and MIO operations
  - Too long for use in VBSS and MIO operations
  - Shore establishment and expeditionary units have migrated from M14
  - Fleet desires M16A3 as replacement for M14 rifle
    - Few M14s to be retained for use in line throwing
    - Currently 4,354 M14 rifles in use aboard Navy vessels
- Replacement of Fleet M14 rifles delayed by loss of acquisition funding and increased requirements for the M16A3. Expect transition to be completed by the end of FY07. 6000 M16A3 rifles to be put into or returned to service during FY07 through repair or conversion actions.

Small Arms
40mm Grenade Launcher Modernization

- Replace the M79 40mm Grenade Launcher with the M203
  - M79 is obsolete
  - M203 is designed to fit onto the M16 family of weapons. Results in increased flexibility
  - Relatively few (<900) M79s remain in service. Too expensive to maintain
- FY06 funding being used to procure 750 each M203s. An additional 500 units will be procured with FY07 funding. Replacement of the M79 should be complete by the end of FY07. (A few M79s will remain in service for use as flare guns during tactical training exercises).

Small Arms
5.56mm Carbine Conversion

- Convert the Model 727 carbine to M4A1 configuration
  - USN is only user of the Model 727 carbine
  - Model 727 carbine is out of production
  - Model 727 carbine is not capable of mounting sighting devices
  - $3.0M of the FY05 O&MN supplemental funding is being used to convert 4000 each Model 727 to the M4A1 configuration (parts procurement and SEAPORT contract).
  - Conversion will take place at a rate of approximately 2000 per year FY07-FY08.
  - Model 727 will be completely replaced by the end of FY08
  - CFFC and OPNAV N864G will determine priority of issue
    - Training Commands
    - Units in direct support of GWOT
    - Deploying Battle Groups
    - Shore stations
    - Remaining Fleet units

Small Arms
Surface Ship Upgrade/MK44 Replacement

- Replace the MK44 mini-gun system with Twin M240 MG.
  - MK44 Mini Gun
    - System provided as a rapid response measure after USS Cole incident
    - Fires 7.62mm at 3,000 rounds per minute
    - Electrically driven w/six barrels
    - 80 systems currently in use by Fleet
    - No spare parts support in place
    - Difficult and expensive to maintain aboard ship
    - Requires ship alt to become a permanent emplacement
    - Acquisition cost $72,300 per system (2 per ship = $144,600)
  - Twin M240 MG (Sufficient FY06 funding to procure 160 ship sets)
    - Fires 7.62mm at 1500 to 1900 rounds per minute (combined)
    - Can continue to fire if one gun fails
    - Any of the ship's M240s can be used to replace failed gun
    - Acquisition cost $22,652 per system (2 per ship = $45,304)
    - Procurement of 300 twin M240 w/mount will cost <$7.0M (150 ship sets)
  - Twin M240 MG will be provided in lieu of the MK44 – More efficient use of funding
  - Transition will be complete by the end of CY07
  - CFFC/SURFOR will establish priorities

Small Arms
Surface Ship Upgrade/MK19 Replacement

- Replace the MK19 40mm Grenade Machine Gun with Twin M2HB .50 cal MGs.
  - MK19 GMG
    - System provided as a rapid response measure after USS Cole incident
    - Fires 40mm grenade
    - Very ineffective when being fired from a moving platform (ship) or at a moving platform (small high speed boat)
  - Twin M2HB MGs originally procured as part of Task Force Hip Pocket
    - Fires .50 cal round at 1000 rounds per minute (combined)
    - Can continue to fire if one gun fails
    - Any of the ship's M2HBs can be used to replace failed gun
    - Transition will be complete by the end of CY08
  - CFFC/SURFOR will establish priorities

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Malcolm Baldrige National Quality Award
2007 Award Recipient

ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER
PICATINNY ARSENAL, NJ

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

M385A1 Composite Projectile Feasibility Study

20 May, 2008

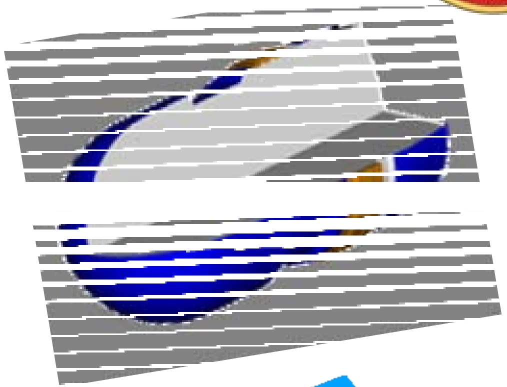
Christopher Summa, 40mm Grenade Ammunition Special Projects

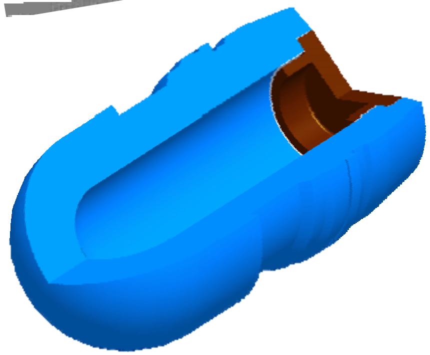
Objectives

- **Objectives**
  - **Reduce unit cost**
  - **Integrate rotating band to the projectile body**
  - **Obtain ballistic match to M385A1**
- **Requirements**
  - **Color – Blue #35109, FED-STD-595**
  - **Maintain Bore Life – 30,000 rounds**
  - **Survive Linking/De-linking**
  - **Accept Ink Stenciling**
  - **Fire from Mk19 GMG**
  - **Preserve Physical Properties**
    - **Profile, Mass, CG, Moments of Inertia**

Rationale

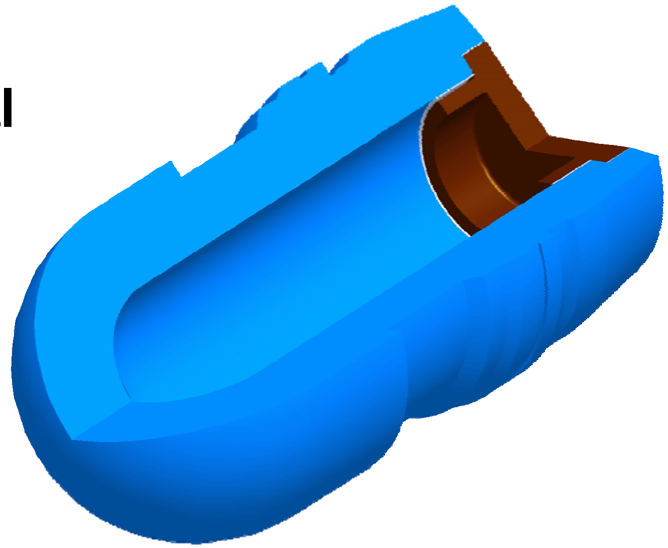
- **Current Fabrication:**
  1. Profile machined from aluminum bar stock
  2. Swage copper rotating band
  3. Final machining
  4. Anodize projectile
- **Fabrication using composites:**
  1. Injection-mold projectile
     - Colorant in compound
     - Can be either stenciled or engraved
  2. Machine and assemble aluminum gas cap
- **Polymer-Metal Powder Composites:**
  – Can use many commercial-grade injection-moldable polymers with metal powder
  – Can tune density to meet mass requirements
  – Can be machined after molding (ideal for prototyping)





Feasibility Study: Overview

- **M385A1 Composite Projectile Feasibility Study**
  - **Characterize and down-select materials (Phase 1)**
  - **Mold, assemble, and inspect prototype projectiles (Phase 2)**
    - **Single-cavity mold with parting line along axis**
    - **Core placed on aft side of projectile**
      - **Core necessary to ensure no voids or other mold related defects**
  - **Conduct Live Fire and Environmental Testing (Phase 3)**



Feasibility Study: Phase 1

- **Material Selection Phase**
  - Ten material recommendations given by Ecomass Technologies
    - 5 thermoplastic polymers combined with 2 different metal fills
  - Performed mechanical properties testing and quasi-static FEA
  - Downselected to 5 materials due to:
    - Chemical incompatibility (-1 material)
    - Insufficient UTS (-4 materials)
    - Mismatching shrink rates (-1 material)
    - Compounding issue (-1 material)
    - Copper-filled materials added (+2 materials)

<u>Materials for Phase 2</u>

Copper + PPA

Copper + Nylon 6/10

Tungsten + PPA

Tungsten + Nylon 6/10

Stainless Steel + Nylon 6/10

Feasibility Study: Phase 2

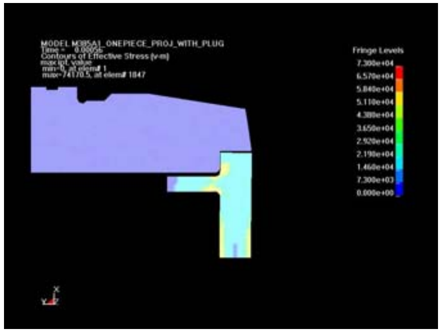
- **Prototyping and Inspection Phase**
  - Gating location in saddle region of projectile
  - Core pin placed in mold cavity to create hollow projectile core
  - 35 projectiles for each material molded (175 total)
    - Inspection shows all are considerably undersized
  - New mold constructed based on previous inspection data and highest shrink rate material – all materials too large would be machined.
  - Equipment malfunction degrades 1 material.
  - Four material groups molded (35 each), delivered to ARDEC (140 projectiles)

Mold Cavity

Untrimmed Part

Feasibility Study: Phase 3

- **Testing Phase**
  - **Environmental Testing**
    - **High Temperature / High Humidity**
      - **Results inconclusive: growth and shrinking experienced**
      - **Post machining may have affected results**
  - **Live Fire Testing from Mk19 Mod 3 GMG**
    - **Two out of four material groups performed very well**
      - **Experienced no break-up despite being undersized**



FEA of Gas Plug

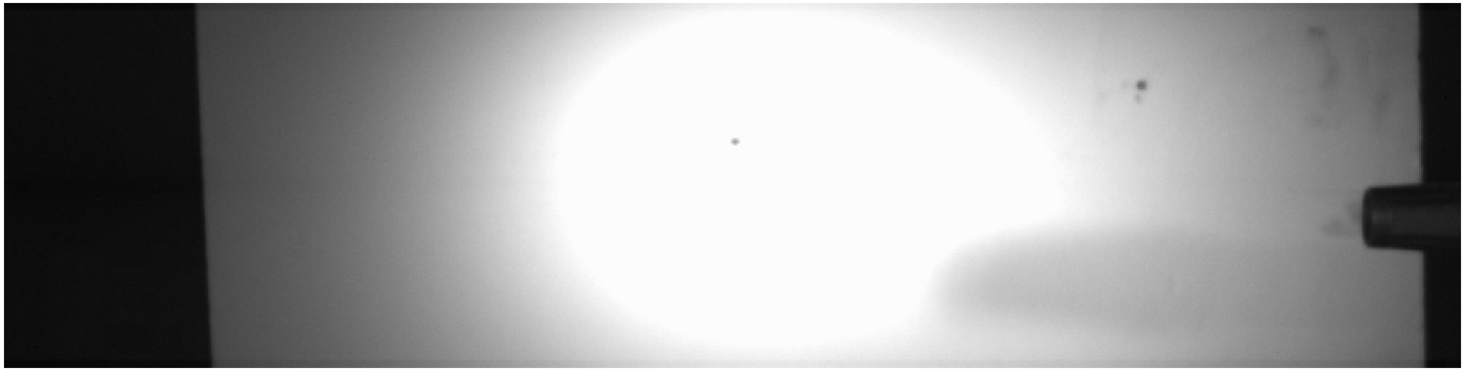
Assembled Projectile

Loaded Cartridge

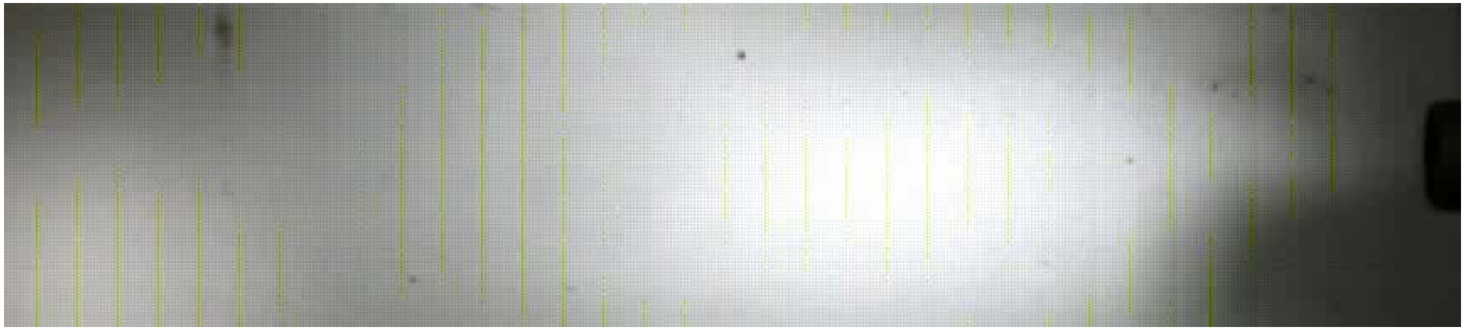
Weapon Setup

Test Firing Videos

Test firing:

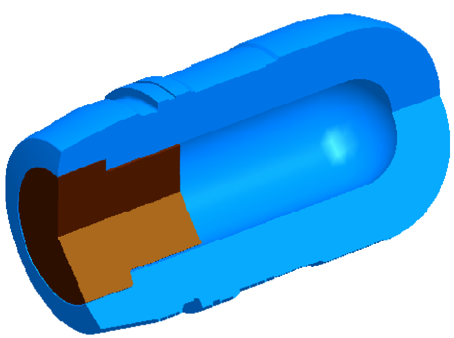


Test firing without gas cap:

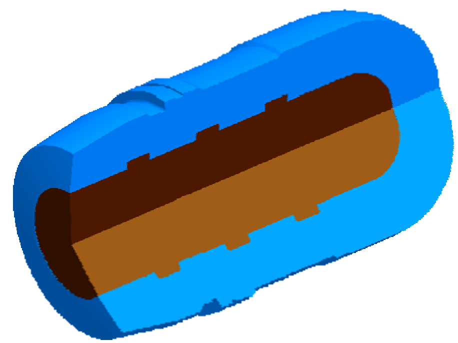


Phase 3 Conclusions

- Composite projectile is suitable for gunfire
  - Requires more testing to demonstrate ability to rifle
- Composite projectile with hollow core not suitable
- Gas cap or mold-in-mold operation may be implemented in future design



Gas Cap



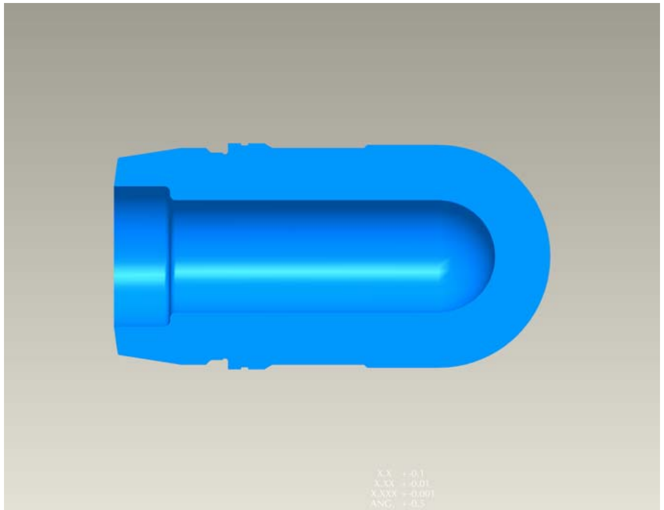
Mold-In-Mold

- Saddle region thickness should be increased to improve strength of part
- Mold modification possible since parts are undersized
- Shape and ballistics of projectile can potentially be made to match those of the tactical cartridge (M430A1 HEDP)
  - Outer profile match not possible with modification to current mold

Feasibility Study: Phase 4?

- Only use best material from original study (SS + Nylon 6/10)
- Perform in-depth Moldflow analysis to optimize mold design
  - Optimized gating for reduced ovality and core pin deflection
  - Improved dimensional stability (only one shrink rate to monitor)
  - Incorporate gas cap recess into core pin
  - Increase saddle wall thickness similar to M430A1 HEDP
- Modify existing mold based on analysis
  - Unacceptable to construct new mold
- Mold and inspect 100 projectiles
- Live fire testing

- In process of pursuing follow-on contract



Benefits to 40mm Ammunition and Warfighter

- Reduced cost for training cartridges
- Increased training quantities for the warfighter
- Possible technology spill-over to other 40mm items
- Potential to utilize frangible qualities of material

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Development of M16A2 Pivoting Coupling

20 May, 2008

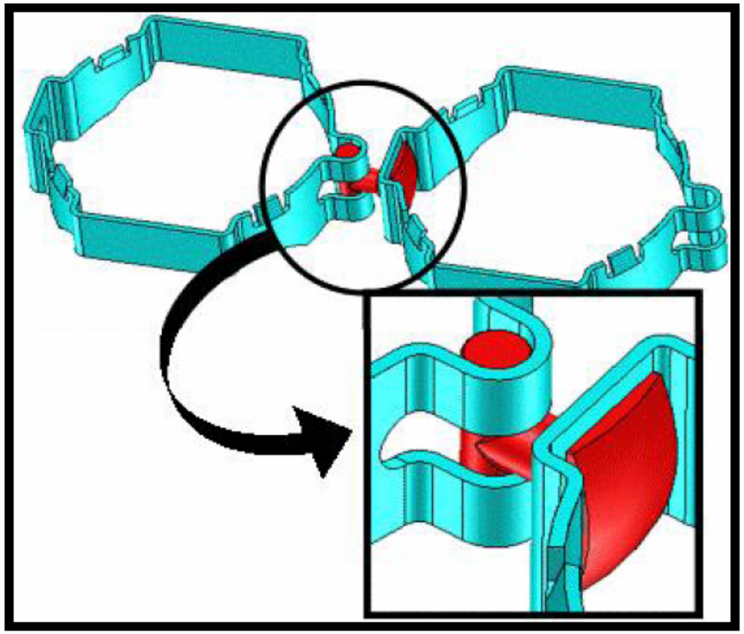
Matthew Millar, 40mm Grenade Ammunition Special Projects

Background

- Soldiers do not have capability to link MK19 ammunition belts together without use of tools
- Current ammo cannot be re-linked to form full belts
- Limited to fire in belt lengths of 32 before reloading

Coupling Design Improvements

- Dimensional modification of current coupling to allow snapping action to secure rounds to the belt without deforming the loop
  - Difficult to spot change visually

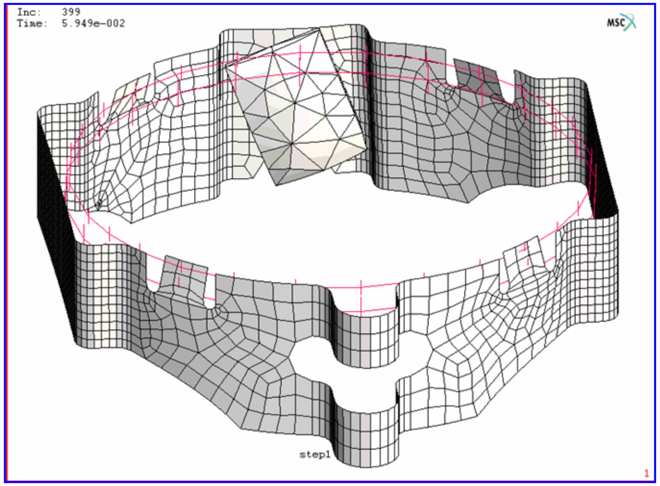


Coupling Coating (cont)

- Reasons for new coating
  - Identification
    - Gold = NEW
    - Black = OLD
  - Corrosion resistance
    - 96 vs. 48 hours
- New coating will be dulled down to reduce coating shine.

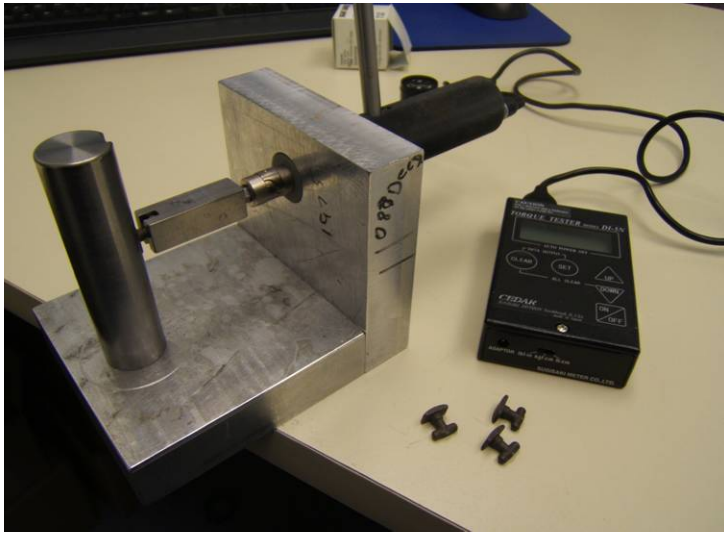
FEA Analysis

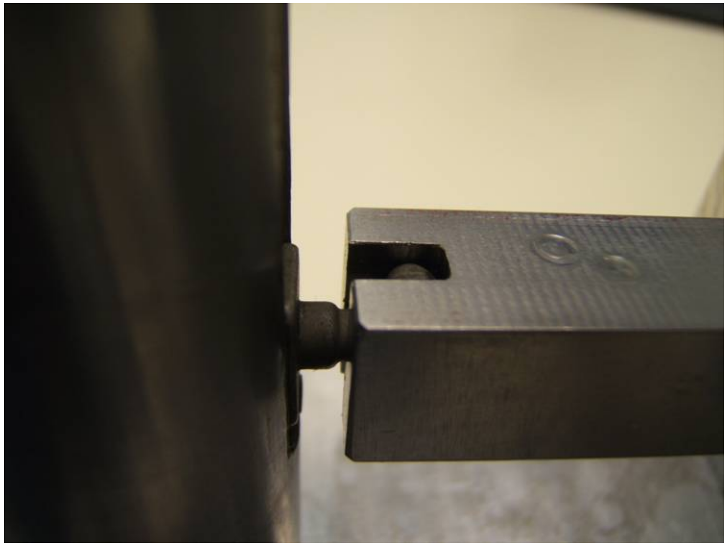
- Investigated mechanical failure during uncoupling/re-coupling
  - Corners of coupling head wear down slightly
  - Loop keyhole opens slightly
- Continued uncoupling and re-coupling did not show any significant decrease in function



Torque Testing

- Coupling and Uncoupling Test
  - Torque gage used to measure coupling and uncoupling
- Torque greatest during first coupling/uncoupling operation
  - Wear on coupling head
  - Loop keyhole elastic deformation
- Coupling shank experienced twist
  - Test fixture represented “Worst Case”
  - Rigid cartridge vs. “Push-Pull” Motion

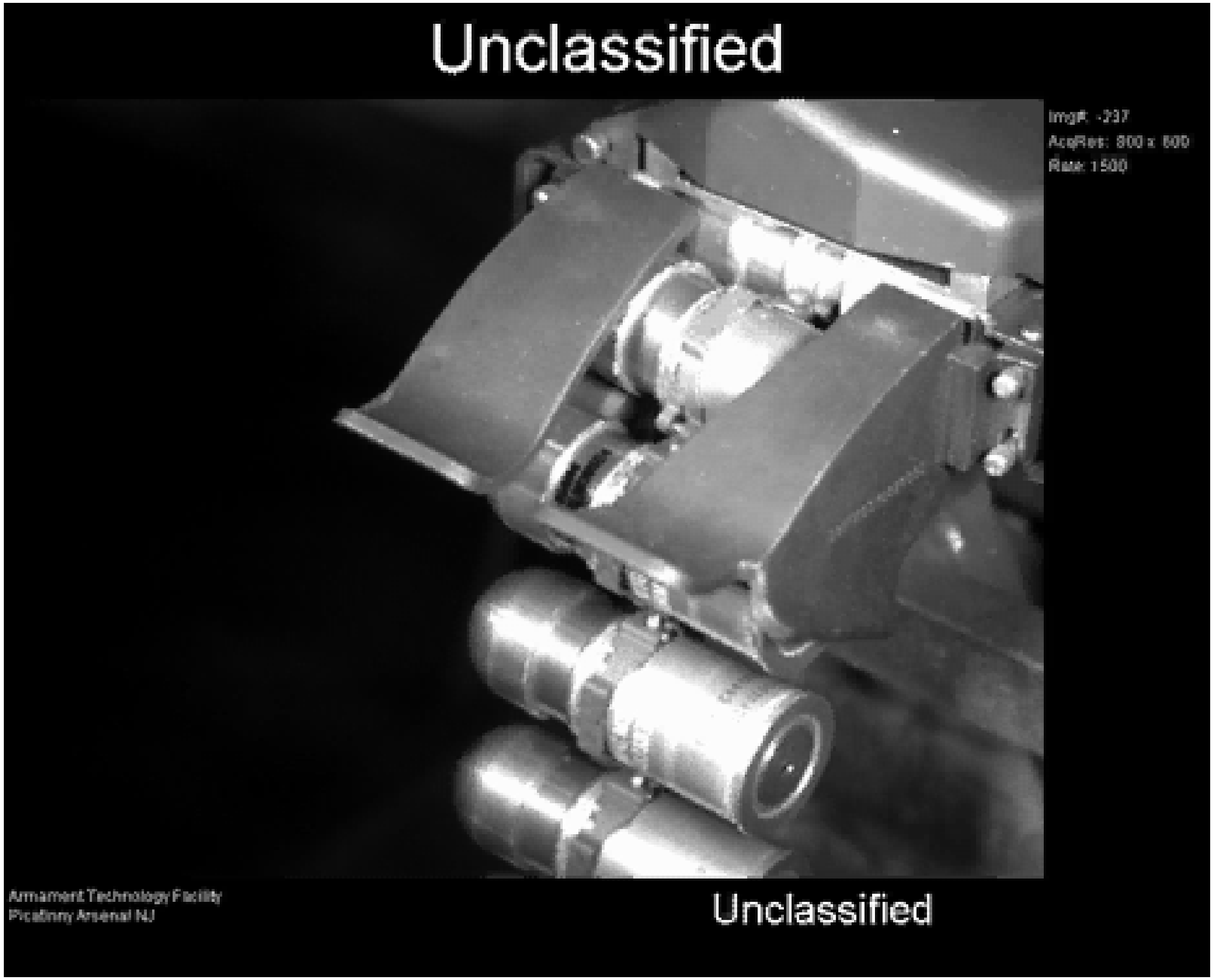




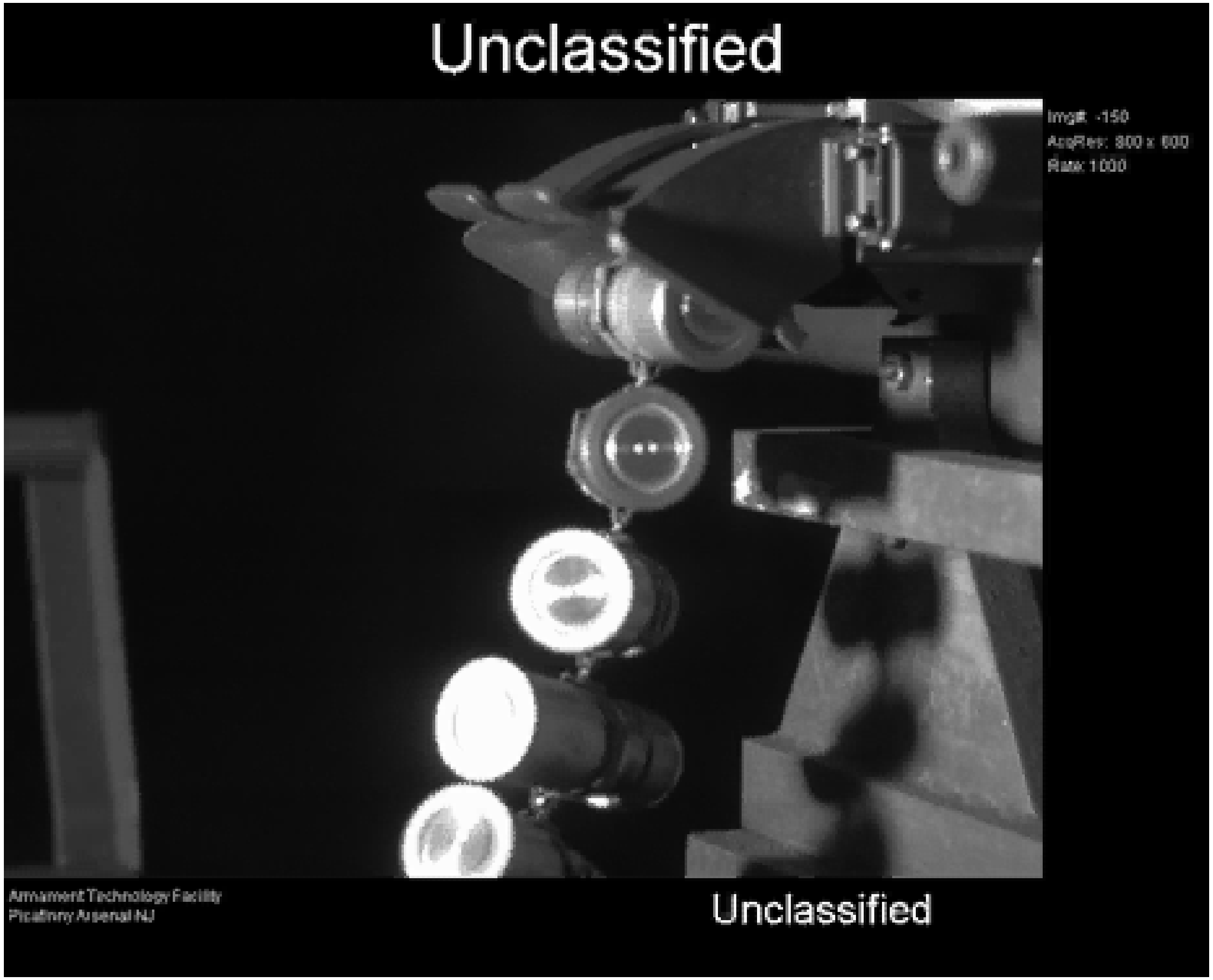
Armament Technology Facility (ATF) Testing

- 15º Twist
  - Three (3) belts of 24-M385A1 linked cartridges
  - Belts fired in 3-5 round bursts as well as 12 round bursts from MK19
  - No weapon stoppages
- 30º Twist
  - 3-5 round burst
  - Multiple configurations
    - Up to 3 cartridges linked with couplings that had a 30º twist linked consecutively
  - 3 consecutively linked couplings with 30º twist caused weapon stoppages
- Testing ceased at 30º twist.

ATF Testing: 15º Coupling Twist No Weapon Stoppage



ATF Testing: 30º Coupling Twist Weapon Stoppage



Vibration Testing

- Vibration Testing at Aberdeen Proving Ground
  - To ensure security of belt during firing from a from moving HMMWV
  - No coupling related weapon stoppages

War Fighter Payoff

- New coupling reduces logistical burden of requiring Ammo Supply Point (ASP) to re-link ammo
- Ability to re-link or extend belts on-the-fly if desired

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Electronics and Sensors in 40mm Low Velocity Grenade Ammo

May 20, 2008

Jason Wasserman, 40mm Grenade Ammunition Special Projects

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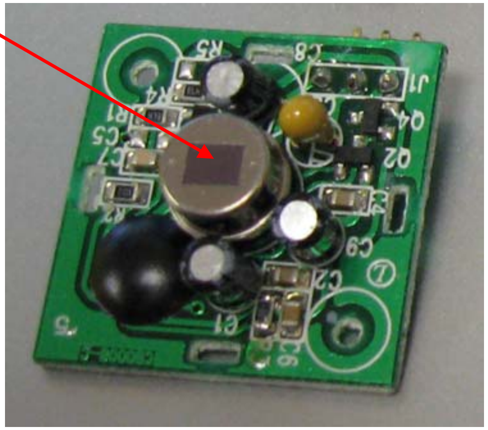
Objectives

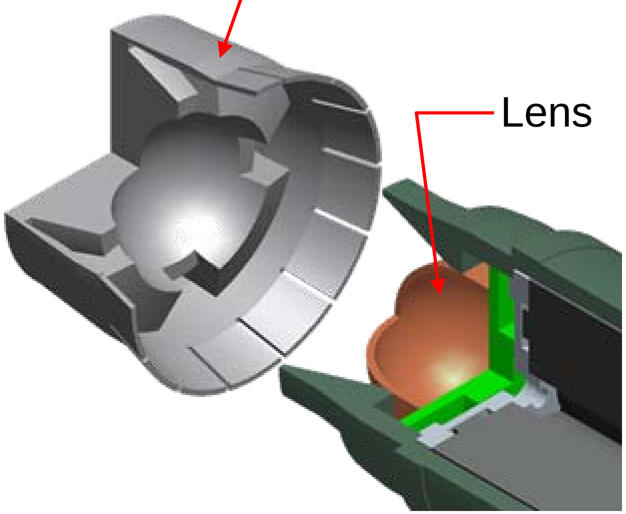
- To integrate commercial, off-the-shelf electronic components into 40mm Low Velocity Grenade Ammunition

- Overcome the challenges associated with integrating commercial parts without modification

PIR (Passive Infrared) Sensor



- Challenges
  - Requires a lens that is transparent to IR frequencies and is structurally weak
  - Translucent visual access to exterior of projectile
  - Proper function requires an unpotted sensor

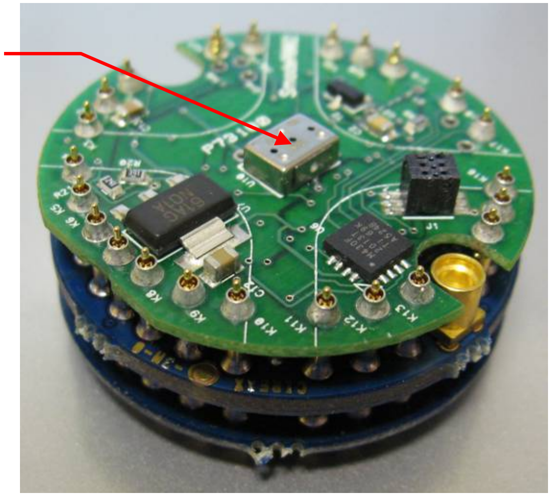


- Solutions
  - Specialized aft geometry to allow the PIR sensor to “see” with a wide field of view
    - “Legs” needed to be strong enough to withstand potential impact loading
  - Specialized pusher utilized to prevent gas leakage from reaching the lens
    - Pusher needed to be robust enough to withstand gun pressures while sensitive enough to detach on muzzle exit to allow the PIR sensor to “see”

Batteries & Microphone

- Battery Challenges
  - Size vs. usable life tradeoff
  - Orientation specific
  - Retention method
- Solutions
  - 2/3AA size used for acceptable size vs. life tradeoff
  - Must be oriented parallel to axis
  - Specialized “spacers” used to hold batteries together to prevent movement and breaking connections

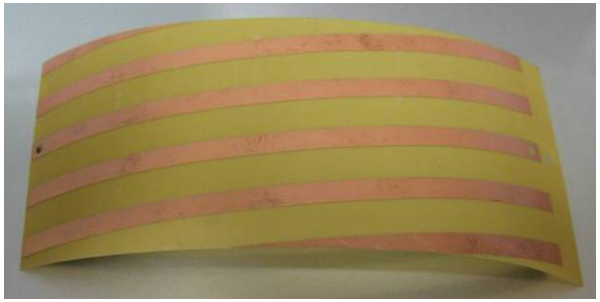
- Microphone Challenges
  - Requires unobstructed, open air access to exterior of the projectile to prevent sound from being muffled or quieted
  - G-load sensitive device
- Solutions
  - Specialized “spacers” used for batteries have built-in channels for microphone and access to exterior of the projectile



GPS Sensor & Antenna/Wiring

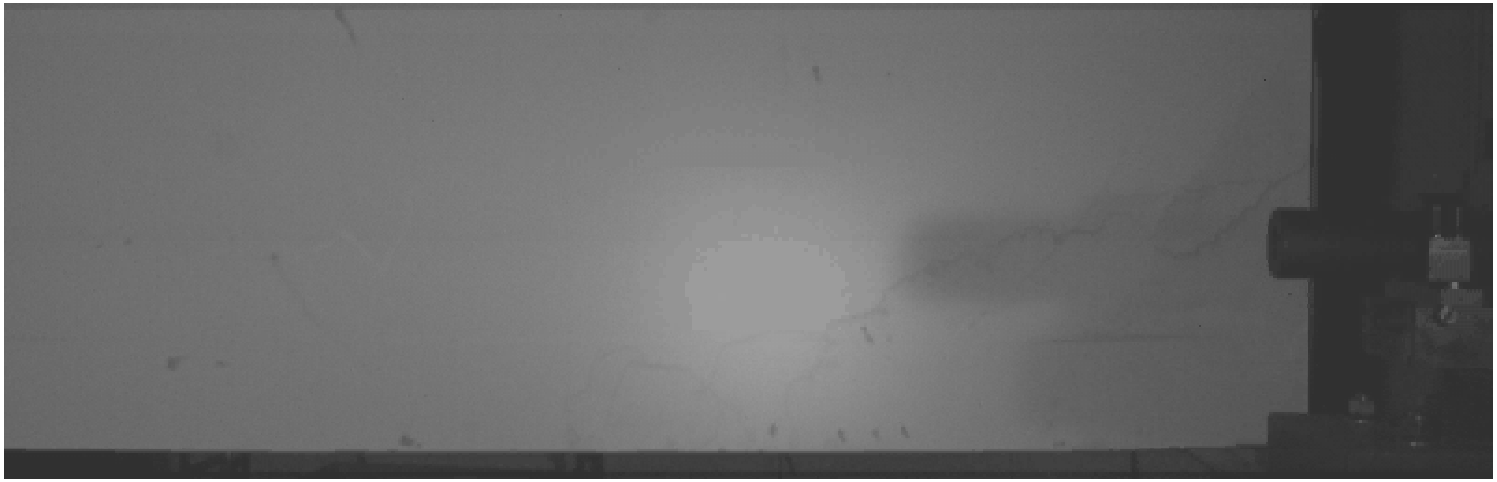
- GPS Sensor Challenges
  - Requires a non-metallic projectile body to prevent the signal from being attenuated
- Solutions
  - High-strength engineering polymer used to retain launch and impact strength without impacting GPS signal

- Antenna/Wiring Challenges
  - Wiring requires space in various spots in projectile body
  - Antenna requires a non-metallic projectile body to prevent the signal from being attenuated
- Solutions
  - Wires are routed in cutouts of battery "spacers" and along the sides of the batteries
  - Antenna is a thin strip wrapped around the outside of the potted electronic assembly prior to inserting into the body



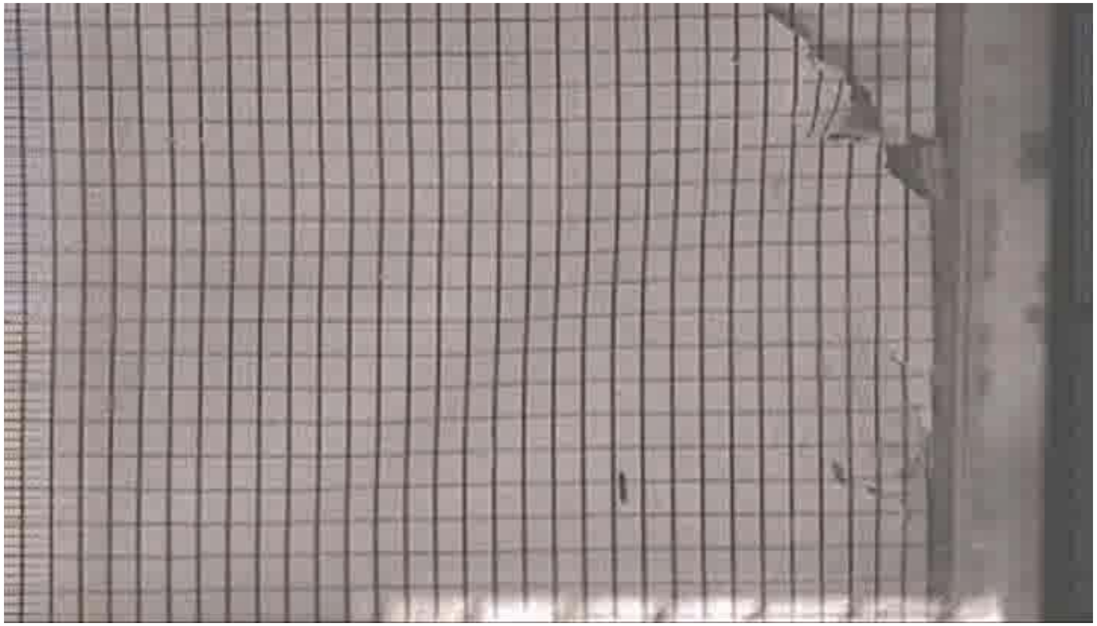
Launch Survivability

- Projectiles were fired from the ARDEC 40mm Low Velocity Mann Barrel
- Objective was to verify integrity and proper discard of the pusher
- Projectiles were soft caught and had signal verification performed by a wireless connection



Impact Survivability

- Testing was performed using an airgun to generate the required muzzle velocities
- Projectiles were fired into a rigid steel plate to simulate worst-case scenario impacts
- Projectiles housed a set of sensors attached by a wired connection to a computer to record real-time impact data
- Various nose designs were analyzed and tested



Path Forward

- Producibility Optimization
  - Reduce time to assemble and pot electronics
  - Procure injection molds
- Live Fire Testing & Demonstration
  - Fire projectiles into various environments and for max range
  - User demonstration

War Fighter Payoff

- Provides a unique capability for Military Operations on Urbanized Terrain at the squad level
  - Non Line-Of-Sight surveillance of enemy or allies
  - Enhanced Situational Awareness
  - Enhanced Target Acquisition

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Malcolm Baldrige National Quality Award 2007 Award Recipient

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Producibility Improvements of 40mm High and Low Velocity Liners

20 May, 2008

Adam Sorchini, 40mm Grenade Ammunition Special Projects

Program Objectives

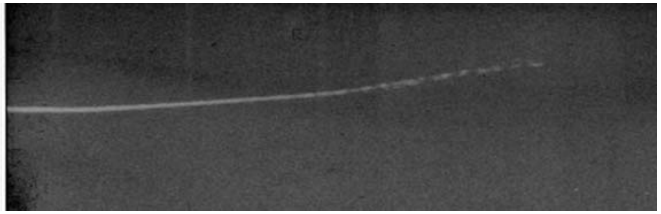
- M433 HEDP One-Piece Liner (Low Velocity – M203 GL)
  - Reduce cost of liner production by combining components
  - Improve efficiency of jet formation
- M430A1 HEDP Non-Fluted Liner (High Velocity – Mk19 GMG)
  - Reduce cost of liner production by simplifying geometry


M433 HEDP


M430A1 HEDP

Baseline Testing and M&S

- Baseline Testing
  - Performed at ARDEC using production hardware
  - Jet tip formation
    - Spin and no spin
    - Events captured by x-ray
      - Tip velocity
      - Jet straightness
  - Armor penetration depth
    - Spin and no spin
    - RHA steel plates



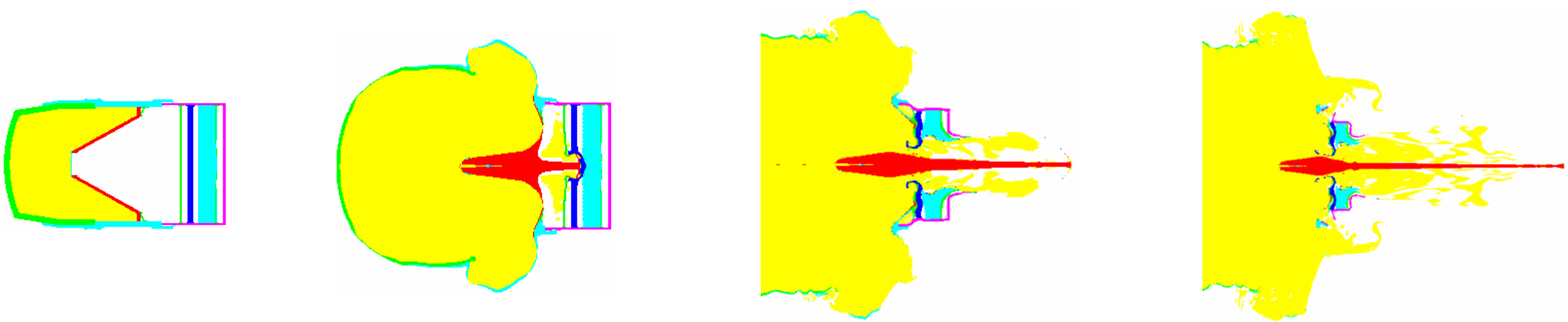
X-Ray of Jet Formation

Penetrated RHA

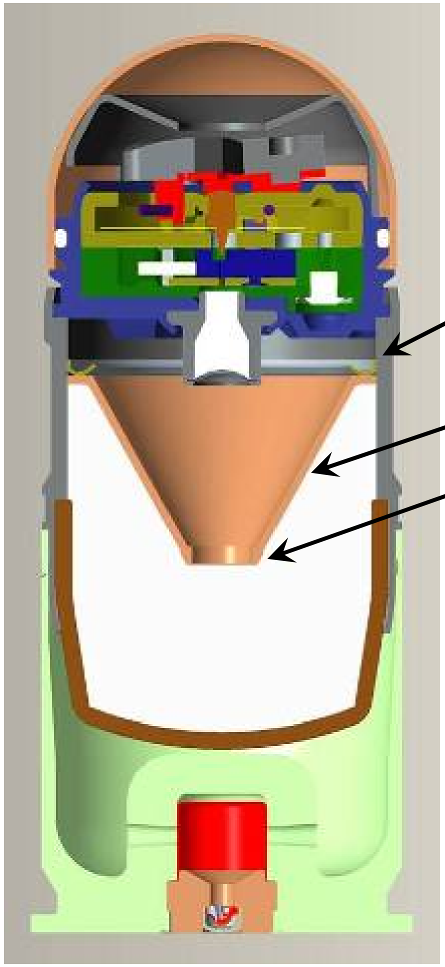
M430A1 Partial Test Projectile

Baseline Testing and M&S

- Baseline Modeling and Simulation
  - Test data feeds into baseline model
    - Model represents actual performance
  - Baseline model is stepping stone to design improvements

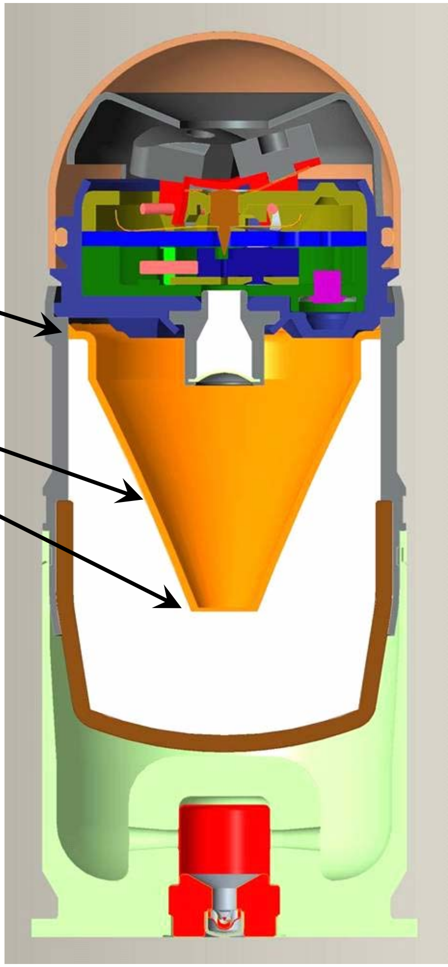


M433 HEDP One-Piece Liner



One-Piece Liner Design

1. Retaining Ring replaced by press fit flange
2. Liner elongated and added radius
3. Liner Cap integrated into liner apex

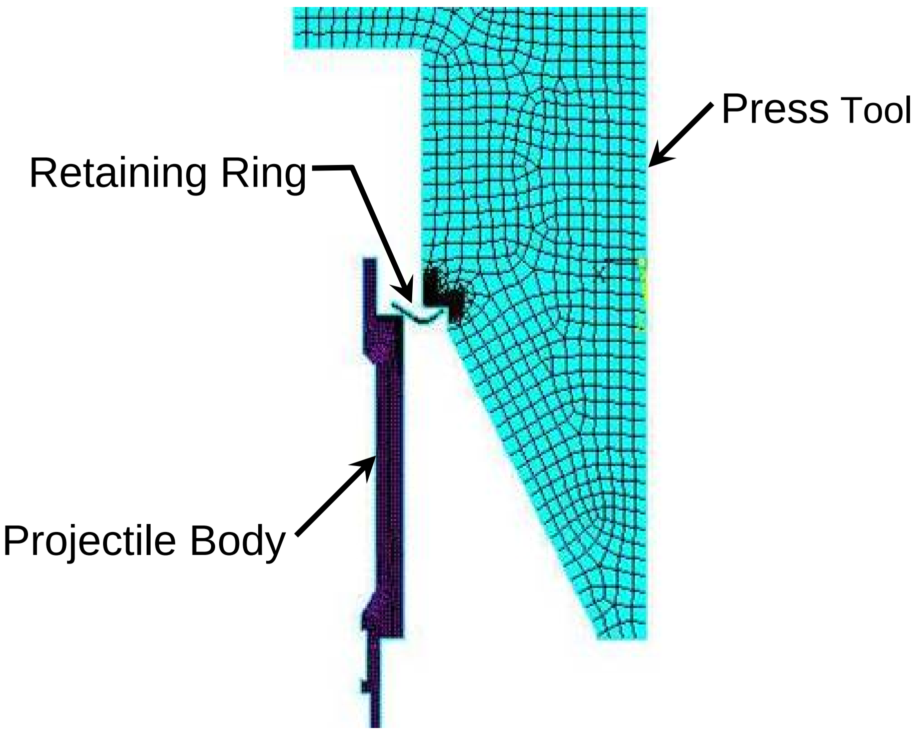


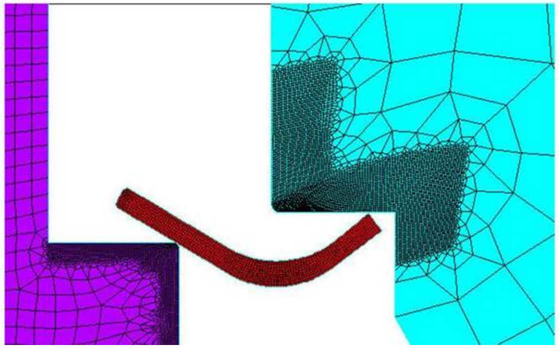
M433 HEDP One-Piece Liner

- Testing & Design
  - Insertion & Push-Out Testing
    - Baseline retaining ring strength (completed)
    - Simulate integrated retaining ring insertion and push-out strength to compare to current retaining ring performance
  - Integrated Apex Sensitivity Testing
    - Perform armor penetration tests to determine maximum allowable apex thickness
      - Sensitivity to initiation determined by spitback performance
  - Optimize Liner Geometry
    - Adjust TDP based on test data and fabricate test hardware
  - Jet Characterization & Penetration
    - Perform full test array to verify performance

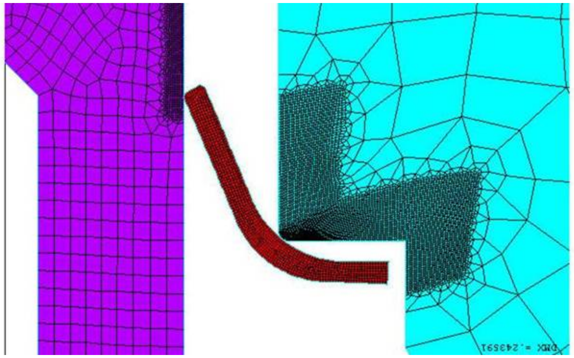
M433 HEDP One-Piece Liner

- Retaining Ring Insertion & Push-Out M&S
  - Validated by test data





Ring prior to deformation

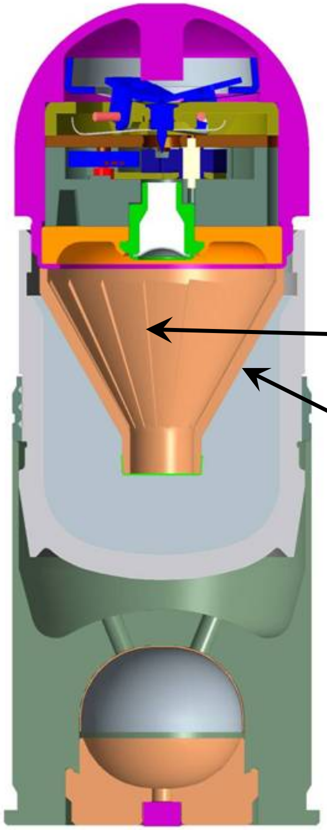


Ring pushed completely in

M433 HEDP One-Piece Liner

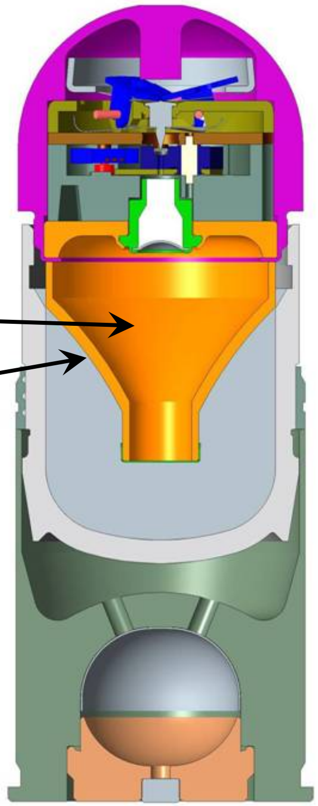
- Manufacturing Progress
  - FCI/Trans-Matic providing manufacturing and design support (subcontracted through DSE, Inc.)
  - Multi-step draw process is used
  - Multiple iterations performed to achieve complex geometry

M430A1 Non-Fluted Liner



Non-Fluted Liner Design

1. Flutes in liner removed
2. Slight radius added to liner

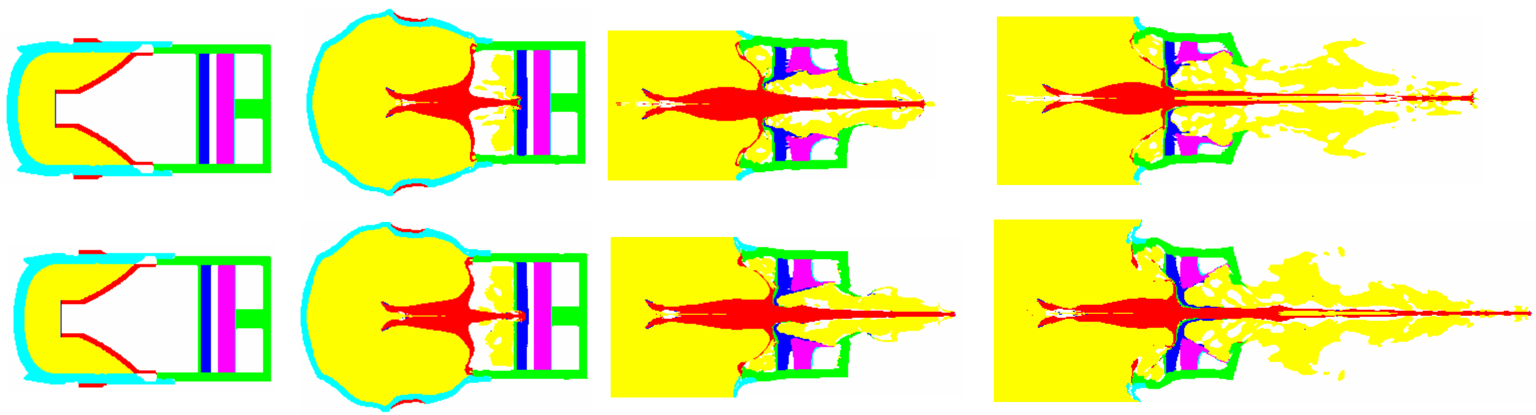


M430A1 Non-Fluted Liner

- Design Testing
  - Jet Characterization & Penetration
    - Spin and no spin
    - Multiple spin rates to be analyzed due to large spin decay over effective range

Fluted Liner

Non-Fluted Liner



War Fighter Payoff

- M433 HEDP One-Piece Liner
  - Lower unit cost
    - Fewer pieces
    - Automated assembly
  - Slight increase in performance
- M430A1 HEDP Non-Fluted Liner
  - Lower unit cost
    - Less complexity
    - Higher production rate
    - Easier to measure critical dimensions
  - Performance
    - More consistent
    - Equal at longer ranges
    - Better at short ranges

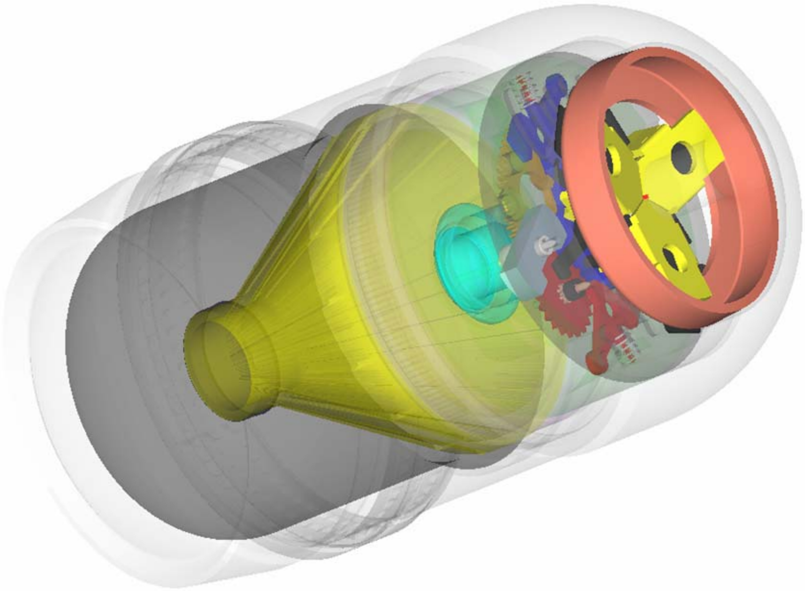
Background

- 40mm Special Projects Team started program to baseline and improve M430A1 HEDP and M433 HEDP 40mm cartridges
- Baselining the cartridges involved Spark Range testing to quantify exterior ballistic coefficients
- Team showed a desire to identify some contributors to flight dynamics

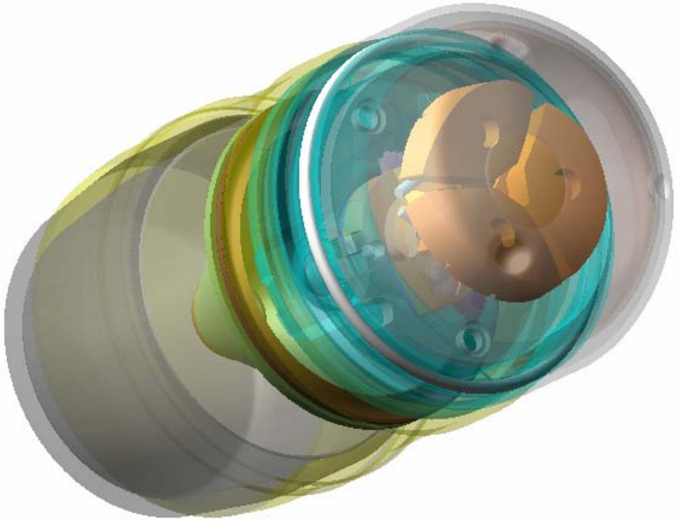
Objectives

- Produce models that track location of center of mass of M430A1 HEDP and M433 HEDP projectiles throughout their flight and arming cycle of their M549A1 PIBD and M550 PIBD fuzes

Transparent Views of Projectiles

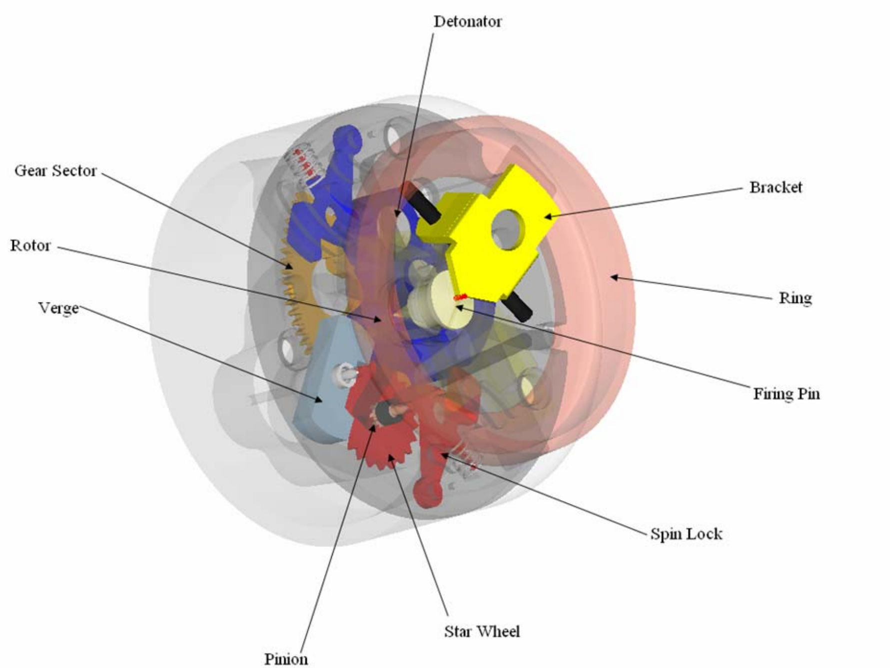


M430A1 HEDP Projectile

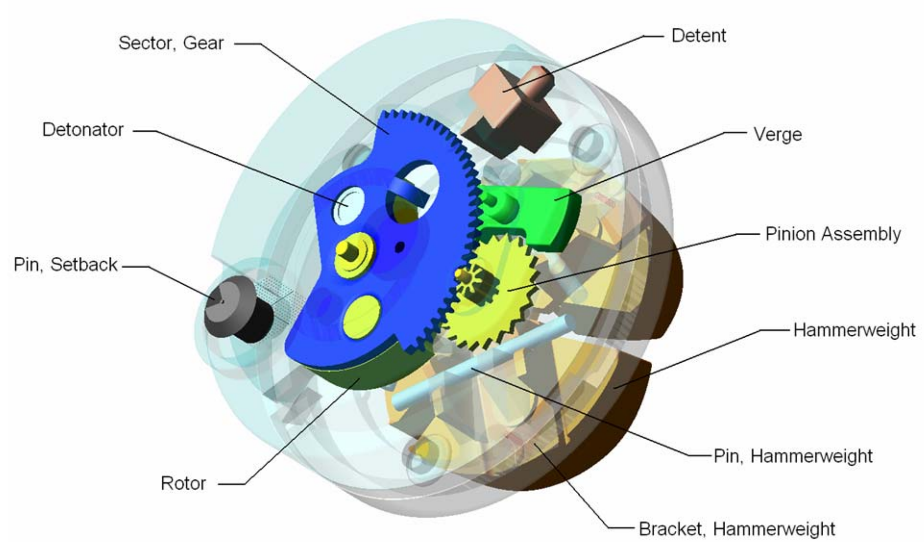


M433 HEDP Projectile

Detailed Views of Fuzes

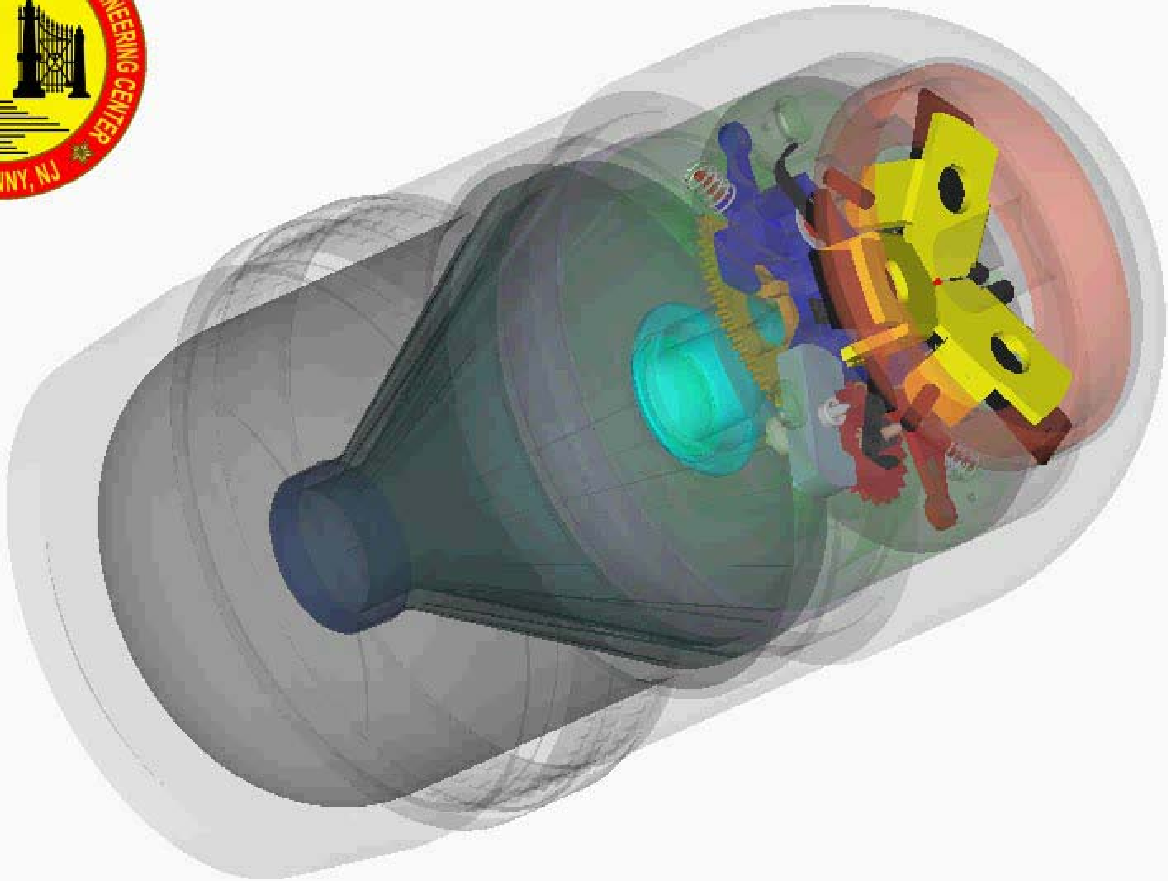


M549A1 PIBD Fuze

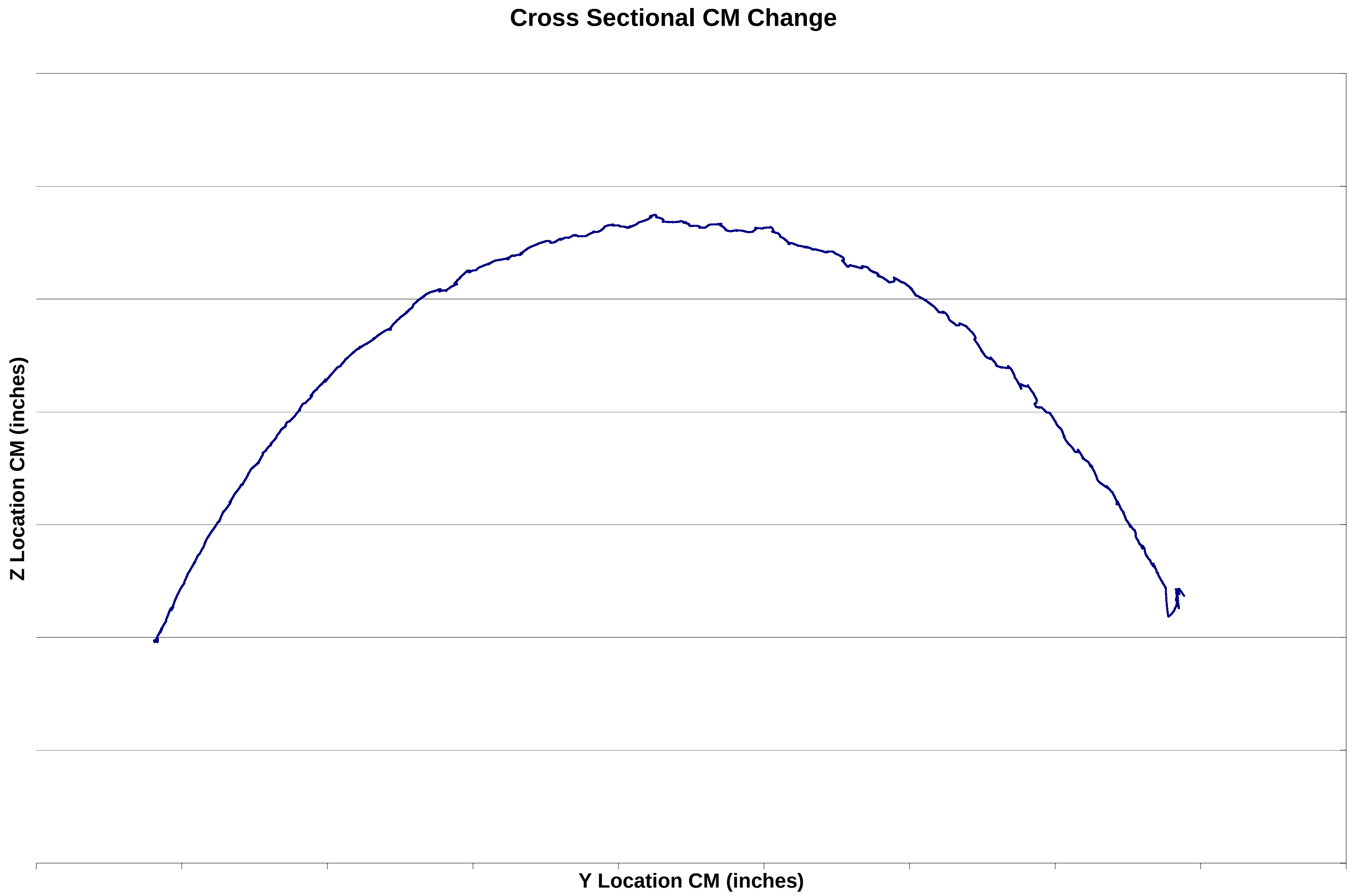


M550 PIBD Fuze

M430A1 Fuze Arming

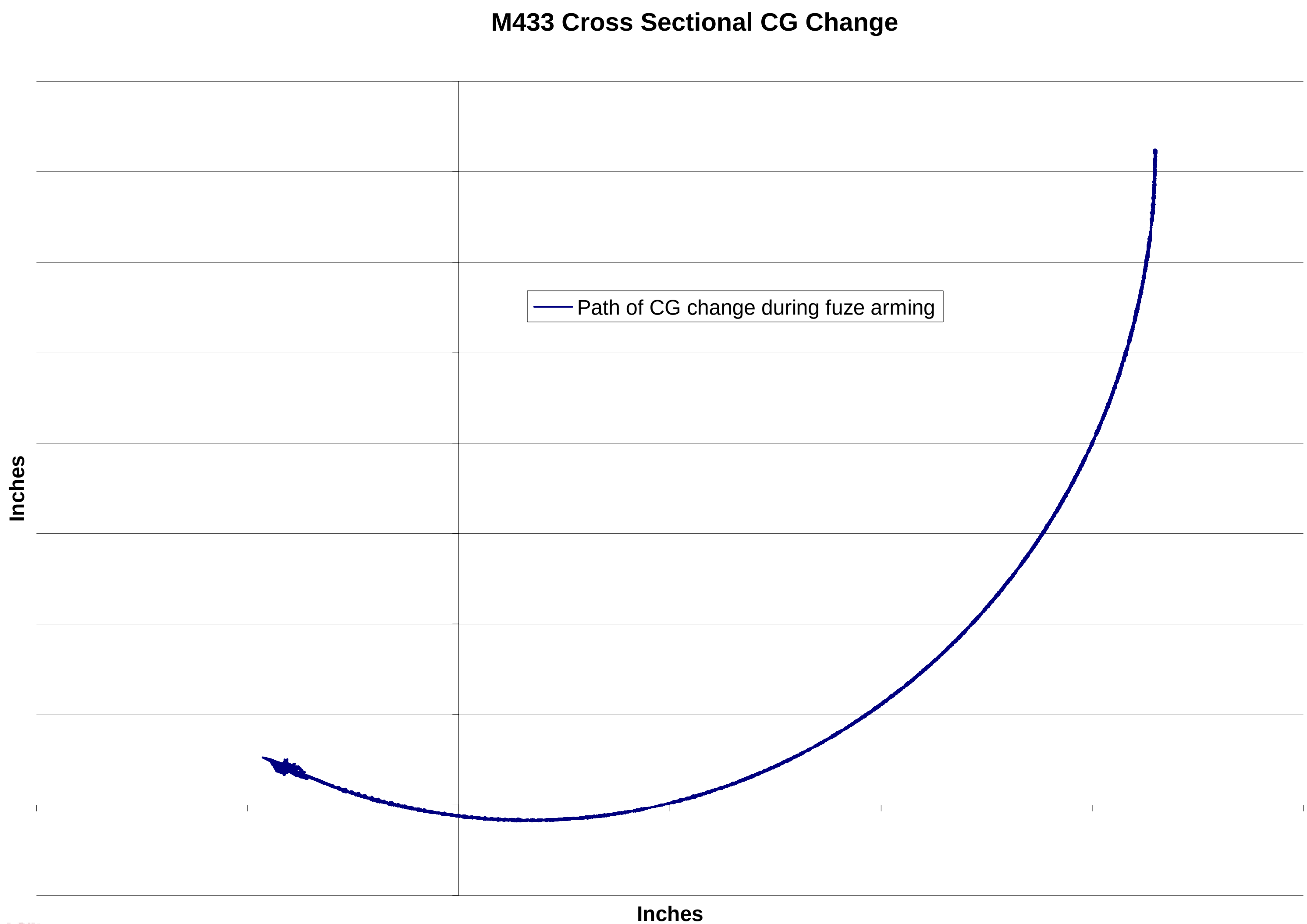


M430A1 CG Data



M433 Fuze Arming

M433 CG Data


M433 Cross Sectional CG Change
Path of CG change during fuze arming
Inches
Inches

Warfighter Payoff

- Clearer understanding of fuze function
  - Establishes basis for simulating improvements
  - Enhances tool set for failure investigations

Technical Reports

- For more Information See Technical Reports
  - ARAEW-TR-08001 "Center of Mass Location Changes in M430A1 Throughout Fuze Arming Cycle"
  - ARAEW-TR-06003 "M433 Center of Mass Location Throughout Fuze Arming Cycle"

RDECOM

Malcolm Baldrige National Quality Award 2007 Award Recipient

ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER
PICATINNY ARSENAL, NJ

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

40mm Day/Night Practice Cartridge for MK13/XM320/M203 Grenade Launchers

May 20, 2008

Peter Martin
40mm Grenade Ammunition Special Projects

Peter.j.martin@us.army.mil

UNITED STATES SPECIAL OPERATIONS COMMAND

PROJECT MANAGER SOLDIER WEAPONS

BACKGROUND

- SOCOM identified need in 2003 for 40mm practice cartridge that would facilitate night and day training with EGLM

- SOCOM elected to pursue solution under foreign comparative test program

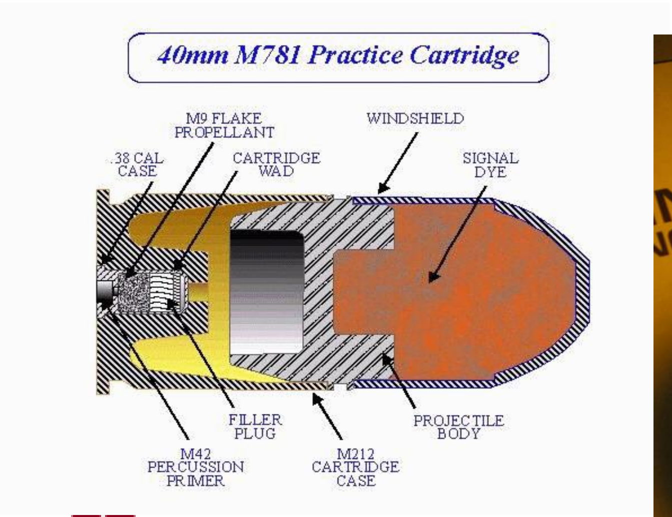
OBJECTIVES
XM1110 D/N Program

- SHORT TERM (6 months)
  - Provide SOCOM practice round to facilitate night as well as day training w/ MK13/EGLM
    - Low cost
    - Non dud producing
    - Environmentally friendly

- LONG TERM (18+ months)
  - Provide all DOD practice round to facilitate night as well as day training w/ M203 and XM320 grenade launchers
    - Low cost
    - Non dud producing
    - Environmentally friendly

SOLUTION

- Capitalizing on the success of the 40mm HV D/N Practice Ctg (MK 281 Mod 1) - Rheinmetall Nico of Germany
  - same propulsion system (ctg case/primer/propellant) as the current M781 practice ctg
  - Chemiluminescent material payload added to the orange powder of the M781 projectile



PROGRAM HIGLIGHTS

- Key Performance Parameters were established and met (April 2007)
- Successful user trials (IOT) conducted (April 2008)
- Qualification & and ballistic table testing (3QTR 2008)
- Initial fielding of the XM1110 ctg targeted for 2009

KEY PERFORMANCE PARAMETERS

- Weapon Compatibility
  - Threshold - safely function and fire from M203 grenade launcher without modification to weapon system
  - Objective - safely function and fire from M203, XM320 and MK13/EGLM without modification to weapon system including current range graduations on weapon sight
- Dispersion
  - Threshold - similar ballistics to M433 HEDP Cartridge
  - Objective - ballistic match to M433 HEDP Cartridge
- Signature Visibility
  - Day signature visible at 350 meters. Night signature visible at 350 meters with or without GEN III night vision devices
- Reliability
  - Threshold - reliability > M781 TP Ctg
  - Objective - reliability >= M433 HEDP Ctg
- UXO/ Range Fires
  - None

TEST PERFORMANCE VIDEO - DAY

TEST PERFORMANCE VIDEO - NIGHT

PATH FORWARD

- **SOCOM Milestone C and production release planned for Sept 08**
- **SOCOM initial fielding expected by 4QTR 09**
- **Army and Marine Corps adoption decision expected in early FY09**

WARFIGHTER PAYOFF

- **SOCOM search for an economical day/night training cartridge is on path to success**
- **Concept of chemiluminescent marker for low velocity 40mm ammo viable solution for night signature**
- **XM1110 has high potential to soon become DOD common practice round with all 40mm low velocity weapons**

JNLWP Update to the International Infantry & Joint Services Small Arms Symposium

Mr Swenson
Acquisition Division Chief, Joint NL Weapons Directorate
(703)432-0906, DSN 378-0906
kevin.swenson@usmc.mil

20 May 07

JSSAST Symposium

- Combined with JNLWP's Joint Integration Program (JIP)
- JNLWP Attendance
- Wednesday Live Fire Demonstration:
  – Weapons: H&K (XM-320), Milkor (M32), CMore (MASS), Beretta (CKER), Metal Storm (MAUL), FN-303 Less Lethal Launcher,
  – NL Munitions: Rheinmetall (Nico) BTV-1 Flash Bang Grenade, Taser XREP, BE Meyers, N Light & Thales Laser Dazzlers, BAE Extended Range Blunt Impact / Marking Munitions, CSI – 12 Gauge / 40mm Warning Munitions, etc..
- Thursday – Non-Lethal Breakout Panel
  – 1050-1230
- Friday – JIP Meeting here at the Fairmont

LETHAL / NON-LETHAL INTEROPERABILITY!

Prioritized DoD NL Capability Gaps
(Top 10 of 36)

Top Ten Tasks

1) Stop Vehicle (small, confined, single)
2) Stop Vehicle (medium, confined, single)
3) Stop Vehicle (large, confined, single)
4) Stop Vessel (small, confined, single, [friendly anchored])
5) Suppress Individuals (confined, single/few)
6) Suppress Individuals (open, many)
7) Stop Vessel (small, open, single, [friendly underway])
8) Deny Access into/out of an area to individuals (confined, single/few/ many)
9) Deny Access into/out of an area to individuals (open, single/few/ many)
10) Move Individuals through an area (open, many)

CP TASKS

- Deny
- Move
- Disable
- Suppress

CM TASKS

- Stop Vehicle
- Disable Vehicle
- Stop Vessel
- Disable Vessel
- Stop Arcft on Ground
- Disable Arcft on Ground
- Divert Arcft in Air
- Deny Access to Facility

CBA Membership

J2/J3/J8	PACOM	USA	JNLWD
JFCOM	CENTCOM	USCG	OSD AT&L
EUCOM	STRATCOM	USMC	*HECOE
	NORTHCOM	USN	
		USAF	

Current Acquisition Programs

Counter Personnel - Developmental Threshold Range At / Below 100M

Mission Payload Module

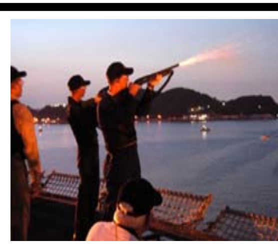
MK19 NL Munition

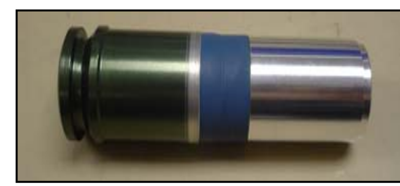
X-26 Taser

Improved Flash Bang Grenade

Counter Personnel - Developmental Threshold Range At / Below 300M

Joint Non-Lethal Warning Munitions





Airburst Non-Lethal Munition

Counter Material

Vehicle Lightweight Arresting Device Net & Remote Deployment Device

Improved Acoustic Hailing Device

Joint Integration Program (JIP)

Description:

A Forum established to Coordinate a Comprehensive Program that Maintains State-of-the-Art NLCS for each Service through Product Demonstrations, Sharing Lessons Learned and Evaluating COTS Products for Potential Inclusion into Service NLCSs.

Recent Accomplishments:

- ❖ Last Semi-Annual JIP Meeting @ Nellis AFB, CA (Nov 07)
- ❖ Next Meeting – 23 Mar here
- ❖ Munitions Testing Standardization MOA (In Coord.)

Ongoing Projects:

- ❖ Evaluate Re-usable 40mm Training Rounds (USA)
- ❖ Evaluate Portable Entanglement Device (USCG)
- ❖ Launch cup w/ Adapters for two Shotguns and User Evaluation (USAF)
- ❖ Extended Range (500-1000 Meters) Warning Munitions (USN)

Future Activities:

- ❖ Evaluating FY09 Candidate Submissions
- ❖ Next Semi-Annual Meeting – TBD (Maritime Venue?)

JNLWD Lead, USMC, USA, USN, USCG, USAF Voters and SOCOM Interest

Industry Contact – **Doug Esposito, American Systems**

douglas.esposito@americansystems.com

Less Lethal Technologies

MECHANICAL & KINETIC

- BLUNT IMPACT DEVICES
- BARRIERS
- NETS/ENTANGLEMENTS
- SPIKES/CALTROPS

ACOUSTIC

- AVERSIVE SOUNDS
- PHASED ARRAYS
- UNDERWATER ACOUSTICS

ELECTROMAGNETIC

1 ELECTRICALS
Examples:
Stun Guns
TASER® Munitions
Primary NL Effects:
Electo-Muscular Incapacitation (EMI

2 RADIO FREQUENCY
Examples:
RF Devices
Electromagnetic Pulse
Wide/Ultra Wide Band
Primary NL Effects:
Electronic Disruption
(Engines/IEDs/Comm)

3 MICROWAVE FREQUENCY
Examples:
Continuous Wave and Pulsed High Power Microwaves
Primary NL Effects:
Electronic Disruption

4 MILLIMETER WAVES
Examples:
Active Denial Technology
Primary NL Effects:
Counter-Personnel Repel Effects

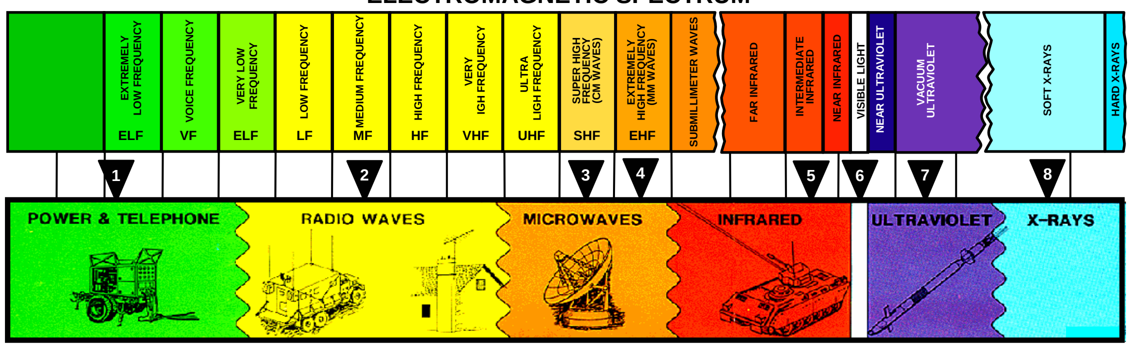
5 INFRARED
Examples:
COIL Lasers
Hydrogen/Deuterium Fluoride (HF/DF)
Solid State Lasers
Primary NL Effects
Counter-Personnel (Deter/Incapacitate)
Counter-Material

6 VISIBLE LIGHT
Examples:
Dazzlers
Broadband/white light
Primary NL Effects
Distract/delay/deter
Illuminate

7 ULTRAVIOLET
Examples:
Laser Ionizer
Primary NL Effects:
Counter Personnel & Counter Material applications

8 X-RAY
TBD

ELECTROMAGNETIC SPECTRUM



Advanced Materials

- RIOT CONTROL AGENTS
- FOAMS
- ANTI-TRACTION MATERIAL
- MALODORANTS
- OBSCURANTS
- THERMOBARICS
- REACTANTS
- MARKERS
- COMBUSTION MODIFIERS

ANCILLARY

- ENCAPSULANTS
- NANOPARTICLES
- NON-LETHAL CASINGS

JNLWP FY09 Technology BAA

- Non-lethal focus areas (in priority order):
  1) Vessel stopping
  2) Clear a space without entry
  3) Divert aircraft
  4) Individual and crowd behavior
  5) Human effects/effectiveness and safety thresholds of NL stimuli
  6) Stimulating academia to promote NLW applied research
  7) Advanced materials and payloads

- Release Date: (Est.) 30 May 08

- Close Date: 30 Jun 08

- Website:
  – https://www.jnlwp.com/admin/solicitations.asp

JNLWP Education Opportunities

- **EDUCATION**
  - **Pennsylvania State University on-line course: <u>NON-LETHAL WEAPONS: POLICIES, PROCEDURES AND TECHNOLOGIES CERTIFICATE</u>**
  - **www.fayette.psu.edu/ccps – application form available online**
  - **JNLWD Point of Contact – LCDR (USN) Cabot Aycock, cabot.aycock@usmc.mil**

- **WEBSITE – https:/www.jnlwp.com**

JNLWD Point of Contact – Teresa Ovalle

teresa.ovalle@usmc.mil

Summary

- Less Lethal Capabilities are relevant in today's fight against terrorism, on both the domestic and international front
- Range is a significant capability gap for Non-Lethal Weapons
- There are a number of promising new technologies that are poised to enhance Less Lethal Capabilities
- The application of Non-lethal force across the Escalation of Force spectrum is critical to success

U.S. Marine Infantry Weapons Update
for the
Joint Services Small Arms Synchronization Team

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

20 May 2008

LtCol Tracy Tafolla USMC
Program Manager, Infantry Weapons
(703) 432-4641 Tracy.Tafolla@usmc.mil

Focus of Effort

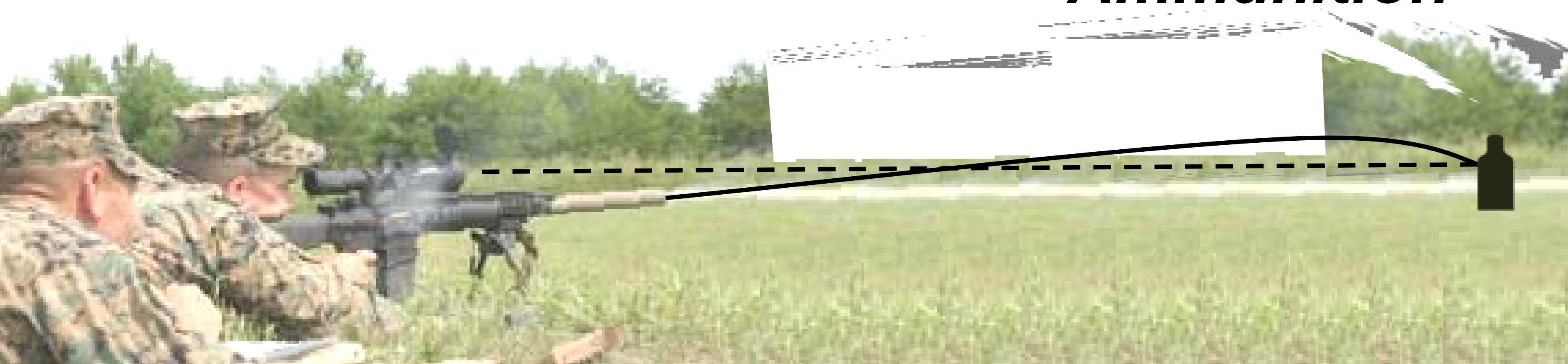
Focus of effort is on increasing the capability and reliability of infantry weapons, in order to increase the skill and confidence of Marines to best defeat multidimensional threats across the spectrum of conflict.

Mitch Paige, January 1943

Holistic Integration

Developing Marines and weapons together as a system…

- ***Marine***
- ***Weapon***
- ***Sight***
- ***Ammunition***



Future Challenges and Opportunities

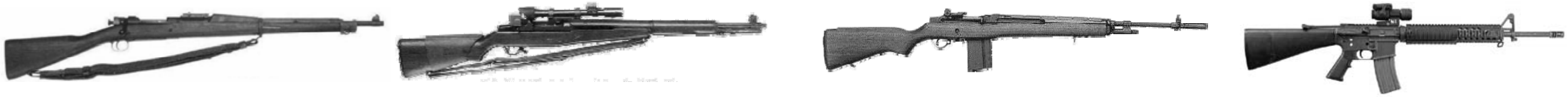
Challenges

- Increase capability while decreasing burden on the Marine
- Gather consensus on service rifle replacement caliber
- Provide scaleable effects – lethal and nonlethal

Opportunities

- Advances in modular, interchangeable design
- Advances in metallurgy
- Advances in ammunition
- Advances in power generation and storage


Questions?



TASER

Protect Life

TASER

TASER Electronic Control Devices

TASER Devices are a well known law enforcement capability for delivering complete yet reversible physical incapacitation. These devices provide the warfighter the ability to control difficult situations where EOF could otherwise result in lethal response.

TASER

Existing TASER Devices

TASER Devices are an established product for military use

Part #	Item	NSN	GSA Price	MSRP	
44000	M26	1095-01-545-5743	$ 399.95	$599.95	600 to DoD, 1400 to other federal agencies (DOJ, DOI, DHS, etc.)
26000	X26	1095-01-528-1930	$ 800.95	$914.95	3000 to DoD, 6500 to other fedreal agencies (DOJ, DOI, DHS, etc.)
44205	21ft Sim Cartridge	1095-01-528-6893	$ 18.07	$31.97	Blue: For training, includes short probe & non-conducting tether
44200	21ft Std Cartridge	1095-01-528-6894	$ 19.02	$32.97	Silver Doors: 21ft range with the standard probe configuration
44203	25ft XP Cartridge	1095-01-533-1733	$ 21.87	$35.97	Green Doors: 25ft range with the XP probe configuraiton
44206	35ft XP Cartridge	1095-01-545-5742	$ 23.65	$38.95	Orange Doors: 35ft range, XP probes, but prefered installation
26701	XDPM	6135-01-528-6895	$ 33.20	$39.95	Extended grip and spare cartridge clip
26752	TASERCAM	5836-01-559-9121	$ 399.95	$499.95	Rechargeable Audio-Video capability replaces XDPM
85001	XRAIL	1095-01-534-4374	$ 100.00	$125.00	Attachement system for X26 to allow mounting on Picatinny rails

*Other configurations of devices and holsters available on request

Federal/GSA authorized distributor: Aardvark Tactical

www.nonlethal.com

800-997-3773

TASER

Existing TASER Devices

US Army is lead for Type Classification of the TASER X26

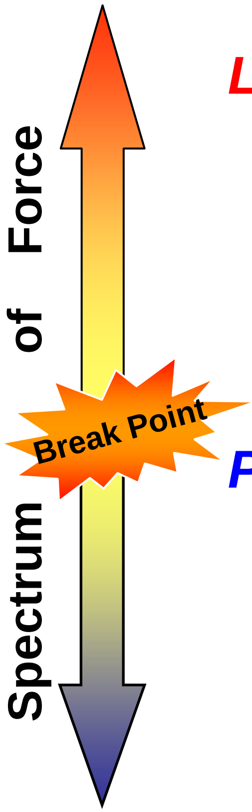
- *Performance/Reliability Qualification Testing - Completed*
- *Launched Electrode Stun Device CPD - Signed*
- *Operational Evaluation/Testing - Underway*
- *Milestone C - Documentation in process, scheduled for 4QFY08*

TASER International is committed to supporting TC

- *IR&D based on feedback of deficiencies*
  - *Improvements made to design and manufacturing process to improve ilities*
- *Improved shipping process and packaging to facilitate DoD requirements*
  - *Improved cartridge and packaging for MIL environments & non-reg. shipping*

TASER

Traditional Military Operations



Lethal Force

- *Lethal—Shoot to Kill*
- *End State:* ***Complete Incapacitation***
  - *Means: One Well-aimed round*

Bullet

Policing Actions

- *Capability to Influence Motivational Behavior*
- *End State: Task Disruption; Dispersal; Crowd Control*
  - *Means: Non-Lethal Capabilities, e.g.,*
    - *Noise amplifiers,*
    - *Rubber bullets, bean bags*
    - *Light distraction*
    - *Heat generators*

Bullhorn

TASER

TASER Devices for Military Operations

Spectrum of Force

Break Point

Lethal Application

Lethal — Shoot to Kill.

Desired End State: Complete Incapacitation

Method of Achieving the End State: Well-aimed round

Escalation of Force

Requires a Capability to Complement Lethal Force

Desired End State: Complete Incapacitation

Method of Achieving the End State: TASER NMI

Policing Actions

Capability to Influence Motivational Behavior

Desired End State: Disruption; Dispersal; Compliance

Neuro-Muscular Incapacitation

TASER

TASER Device Risks

Overview of Recent Research

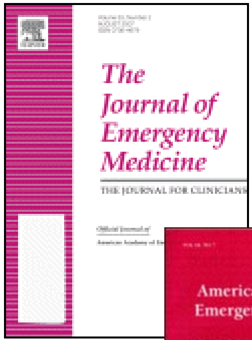
2007

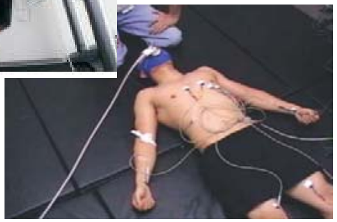
•16 Journal Articles Published and19 Presentations

•Approximately 200+ volunteers of varying degrees of health were monitored Pre, During, Post and 24 hours Post ECD exposure in 2007.

•Blood Chemistries, Stress Hormones, Breathing, Body Core Temperature, Heart Monitoring via12 lead EKG and Ultrasound were some of the data points collected.

•Recent news about published studies are available at: www.TASER.com/research/Science





TASER

TASER Effectiveness and Safety

- *Effectiveness*
  - *94% effective in field use and proven track record*
- *Accountability*
  - *Dataport download feature*
  - *TASER CAM*
  - *Anti-Felon ID confetti*

- *Safety*
  - *2000+ pages of medical and field test data*

- *Injury Reduction*
  - *Consistent and significant injury reduction*

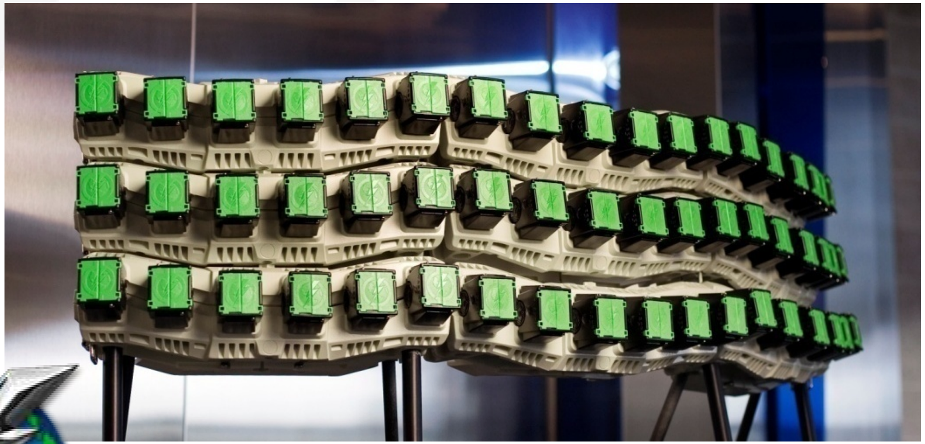
TASER

TASER SHOCKWAVE

- *Shockwave for area denial*
  - *Suspicious Pedestrian traffic*
  - *Vehicle/asset protection*
  - *Containment*

- *Modularity for flexible use*
  - *Interlocking features and "Daisy Chainable"*

- *First units available May, 2008*



TASER

TASER International Wireless Projectile

XREP - eXtended Range Electronic Projectile

- 14 g; wireless; range 65 feet
- Beta testing underway
- Final design summer 2008
- Production 1Q 2009

X12 Less-Lethal Shotgun

- by Mossberg
- Radial™ ammunition key
- High twist rifling
- Distinctive coloring

TASER

40 mm HEMI Program Overview

Human Electro-Muscular Incapacitation

- DOD term adopted for Neuro-Muscular Incapacitation
- Intended to describe an effect but… associated with electronic projectiles
- **The Army is lead service for HEMI Program of Record**
    - HEMI COE underway
    - Capabilities Development Document (service requirement) is being built around the 40mm platform

TASER

40mm HEMI Cartridge

- Why 40mm?
  - Greater weapon availability
  - Emerging requirement
  - Greater range possible
  - Greater attainment possible

- TASER International is under contract from the JNLWD for 40mm concept development culminating in a field demonstration of 40mm HEMI cartridges
  - 24 month program
  - $2.5M contract

TASER

TASER

Protect Life

NDIA
Armament Division
Small Arms Systems Symposium
And
Firing Demonstration

Status and Activity Update 2008
19-22 May 2008

Dave Broden
Armament Division Chair

Enhancing Small Arms Effectiveness in Current and Future Operations

Address and Focus on the Theme

DoD and Homeland Defense Capabilities

- Joint Force operations and capability
- Response to asymmetric threats
- Adapt systems and technology for operational flexibility — Jointness
  - Responsiveness

- Push technology envelope(s)
- Push integration efficiencies
- Add functional capabilities
- Introduce new systems
- Ensure readiness and capability

"Lessons Learned" — Readiness/Capability — Responsive Force — Jointness — Technology Change

Shape the Future — Enable the Force

2008 Armament Division Overview

- Armament Division Overview Status
- Key Strategic Focus Initiatives Impacting NDIA—Armament Division
- Highlights of NDIA Status Report and Division Leadership Meeting
- Communicate NDIA Initiatives
- Seek Expanded Dialogue and Input from Memberships
- Seek Open Dialogue to Identify Suggestions to Ensure Value to all NDIA Membership
- Emphasize NDIA Impact Communications

NDIA Management
Headquarters and Division Leadership
Is
Focused to Ensure Value and Impact Meeting Mission Objectives

NDIA Missions

- **Advocate:** Cutting Edge Technologies, Superior Weapons, Equipment, Training, and Support for America's 4 and First Responders

- **Promote:** Responsive and Vigorous Government-Industry National Security Team.

- **Provide:** Forums for the Exchange of Information between Government and Industry on Matters of National Security.

Organization Objective: ***Provide "Value Added" Symposiums and Activities Ensuring Mission Objectives***

Armament Division---Division Activity

- **Division Goals:**
  - **Provide a Forum for Industry and Government Partnership Addressing All Types of Armament Systems Ensuring:**
    - **Assessment of Current Armament Systems**
    - **Vision and Awareness of Emerging Needs, Technologies and Systems--- *"Lead the Way Ahead"***
    - **Enabling Superior Operational Capability Thru Integration of Advanced Technology**

- **Division Approach to Goals:**
    - **Maintain and Strengthen Government—Industry *Partnerships***
    - **View Symposia as *Training and Education* Opportunity**
    - **Focus on *Continuous Improvement* of Symposia**
    - **Implement *Symposia Themes* with Focus and Impact**

Armament Division---Division Activity

- **Armament Division Management Approach:**
  - **Monthly Division Telecom with NDIA Staff**

  - **Armament Division Executive Meeting —Strategies etc.**
    - **October (with AUSA)**

  - **Executive Committee Meetings**
    - **At Symposia– (March-May)**
    - **Summer Meeting (June)**
    - **Fall Meeting (October—with AUSA)**

  - **Symposium Planning**
    - **Gun and Missile Systems—December**
    - **Small Arms Systems—January**

  - **Communications: On Going Regular Email Status Etc. As Required**

Armament Division--- Leadership Focus Meeting

- **NDIA National Headquarters and Division Leadership Meeting**
  - **Meeting April 2008**
  - **Focus on Status and Vision for NDIA**
  - **Key Topics:**
    - **NDIA Status Activity Overview**
    - ***Science, Technology, Engineering, and Mathematics (STEM)—Initiatives and Actions***
    - ***Top Issues—Input and Status Re: Member Benefits***
    - **Legal/Ethics**
    - **Logo Style**
    - **WebSite Upgrade**
    - ***Division Cooperation and Growth***
    - **Links to Chapters**
    -

Armament Division

- **Key Armament Division Activities:**

  – **Annual Symposia**

    - **Small Arms Systems**

    - **Gun and Missile Systems**

  – **Monthly Armament Division Leadership Telecoms**

  – **Strategic Focus Improvement Initiatives**

    - **Across Division—Inter-Committee—Address a Issue**
    - **Within Committees**

  – **Combined Division Symposium —Planned at Three Year Intervals—** ***Planned for 2010***

  – **Education and Training Initiatives during Symposiums**

    - **Successful During Gun and Missile 2008—** ***Acquisition Training***

Leadership

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

Objective: Coordinated Focus and Vision for Armament Systems

Armaments Division

Dave Broden

Committees

Small Arms Systems

Brian Berger

Gun And Missiles Brian Tasson

Guns/Ammunition

Rockets/Missiles

Future TBD

TBD

Themes, areas discussed; no specific action

Responsive Organization – Ensures Relevance

Scope – Area of Interest – Responsibility Definition Clarity

Establishing and Ensuring Strategic Focus

Armament Division

- **Leadership:**
  - **Armament Division Chair:**
    - **Dave Broden**
    - **Broden Resource Solutions LLC**
  - **Small Arms Systems Chair:**
    - **Brian Berger**
    - **GD-OTS-Canada**
  - **Gun and Missile Systems Chair:**
    - **Brian Tasson (May 2008)**
    - **ATK –Mission Systems Division**

Committee Scope

Gun and Missile Systems

Small Arms Systems

- Individual weapon(s)
- Crew served weapon(s) (e.g., ≤ 40mm)
- Lightweight Systems
- Ammunition
  - Enhanced/lightweight
  - "Green"
- Full life cycle management
- Supportability
  - Training
  - Logistics
- Target Acquisition/Fire Control System (TA/FCS)
- Remote Stabilized Turret System
- System Integration
- Networked capabilities
- Non lethal
- Homeland Defense systems

Guns and Ammunition

- Medium caliber systems
- Tank systems
- Mortar systems
- Artillery systems
- Naval gun systems
- Aircraft/helicopter systems
- Precision systems
- Platform Integration
- Manned/robotic applications
- System integration
- TA/FCS
- Supportability
- Life cycle management
- Stabilized Turret System

Missiles and Rockets

- Tactical missiles and rockets
- Shoulder Fired Systems
- Ground launched
- Aircraft/helicopter launched
- Precision Systems
- System Integration
- Manned/robotic applications
- Life cycle management

Synergism → Commonality

Common Enabling Technologies, Modeling/Simulation, Man-Tech

Links to Other Committees

Guns and Ammunition

Rockets and Missiles

Strengthening Capability through People and Technology

Addressing the Theme!

- Joint Capability
- Joint Requirements
- Readiness Capability
- Linking People and Purpose

Ensuring Readiness of People, Technology and Systems

Applying Common Advanced Technologies and Integrated Systems

Enabling an Integrated and Responsive Joint Force Capability

Symposium Attendance Realizing Growth

- **Gun and Missile Systems**

  Attendance---350-500 in last 5 years

- **Small Arms Systems**

  Attendance—400-550 in last 5 years

Expanded Participation

Strategic Focus

New Attendees and repeat attendees

Growth of Exhibits

Continued International participation

- **Interest and Activity Strategically Focused**
- **Armament Division meets Needs of Government and Industry**

Armament Division---Division Activity

- **Executive Committee Discussions/Decisions:**
  - **Strategic Focus Topic Considerations**
    - **Review/Discussion of Topics**
    - **Decision Addressed Desired Role of Committees**
      - ***Primary Focus is on Symposia only***
      - **Other Topics Addressed on Volunteers Only-Special Case**
  - **Symposia Improvements and Changes**
    - **Implementing Quality Initiatives to Ensure High Quality in All Presentations—Content-Format—Value etc.**
    - **Seeking Theme Topic Presentations vs. Response to Call for Papers Only**
  - **Addressing Executive Committee Membership**
    - **Uniformed Personnel**
    - **Industry Mix of Companies etc.--**

Armament Division– Education Initiatives

- **<u>Focus on Evolving and Changing DOD Education Requirements:</u>**
  - **Education Needs are a National Priority**
    - ***<u>STEM Division Formed and Moving Effectively</u>***
    - **NDIA Can/Should Impact**
  - **Science, Technology, Engineering, Mathematics (STEM) is a Critical National Need**
    - **Increasing Attention Throughout the Nation**
      - **Impacts Not Only Defense but all Technology Areas**
      - **Aerospace/Defense Will be Significantly Impacted**
        - **Babyboomer Retirements**
        - **Low Numbers/Low Interest in Education Pipeline**
  - **NDIA STEM Initiative Including *<u>PLTW</u>* Establishes Focus**
    - ***<u>Action: NDIA Member Companies—Members-Divisions/Chapters Must Commit to Programs Enabling STEM Education Incentives etc.</u>***

Armament Division—Education Initiatives

- **STEM Initiatives:**

  – **Executive Committee Members Will Encourage Their Companies to Seek Partnerships with Schools via *PLTW etc.***

  – **Executive Committee Discussion of How Armament Division can Support STEM Initiatives**
    - ***PLTW***
    - **Other Unique Initiatives**

  – **Armament Division Annual Report Presented at Symposia Highlight Importance of STEM**

    - **2008 Report will Emphasize NDIA Partnership with *PLTW***

  – ***PLTW* == *Project Lead the Way***

Armament Division– Education Initiatives

- **Focus on Evolving and Changing DOD Education Requirements:**
  - **Suggested Action Plan:**
    - **Division/Chapter Commitment to STEM Workforce Division**
      - **Establish STEM Initiatives In Each Division/Chapter**

        Contact Schools—Link to *PLTW*

        Seek Similar Initiatives Where Appropriate

        Mentoring/Student Days etc. in Member Companies
      - **Suggest STEM Workforce Division Establish a Brochure etc.— *Outlining Benefits of STEM Education and Career***
      - **Seek to Support "Intern Programs" in Companies and Communities**
      - **Utilize Retired STEM Career Personnel in Mentoring**
      - **Address Expanded *"Life Long Learning"* and *"Education Updates"* with Babyboomer etc. to Extend Careers and assist in New Students**

2008 Top Defense Issues

- **Issue 1: Sustain The US National Security Workforce Advantage**

- **Issue 2: Ensuring The Integrity and Responsiveness of the Acquisition Process**

- **Issue 3: Maintain a Viable Defense Industrial Base to Ensure Warfighter Readiness**

- **Issue 4: Improving Small Business Access to Defense Contracts**

- **Issue 5: Preparing for Defense Transformation**

- **Issue 6: Ensure International Competitiveness of US Defense Industry**

NDIA Board of Directors Approved Focus
NDIA Focus Issues to Congress

Armament Division—Strategic Issues

- **Influence Process and Activities:**
  - **Top Issues and Related Actions**
  - **National Defense Magazine**
  - **“What Do Division Members/Executive Committee See as Issues?”**
  - **Symposia—Way to Communicate and Impact**
  - **‘Sponsorship of “Awareness Briefings/Meetings”**
  - **Special Studies**
  - **Special “Endorsements– e.g. STEM— *PLTW etc.***
    - ***Attention to Education Needs--Opportunities***
  - **Chapter—Focus Topics**
  - **Divisions---Identify Issues---Communicate Impact**
  - **Links with Other Business Organizations**

Armament Division—Strategic Issues

- **Participation in Development of Annual Top Issues:**
  - Communicating ***Results of Actions***
    - Confirms Value—Increases Interest
    - Need ***Clarity of Results and Impact*** on Industry and Members
  - Division Chairs Must Include Top Issues in Exec. Comm. Agenda
    - ***Communicate Top Issue Up and Down***
  - Division Committees Need "Annual Call for Issue Topics"
    - Currently Informal—National Should Require
  - Include a ***Top Issues Presentation in Each Symposium***
    - Need to Work Out Who and How

      Coordinated Input from National—TBD?

Armament Division—Strategic Issues

- **Developing Annual Top Issues:**
  - **Objectives:**
    - **Division/Chapter Participation**
    - **Individual Membership Interest/Value/Benefit**
  - **Observation:**
    - **"Top Issues"– Are Perceived as a NDIA Leadership Topic**
      - **Divisions/Chapters/Members—Do not Relate/Connect to Issues-----Emphasis is Focused on Networking**
  - **Considerations:**
    - **NDIA Communicate "How Divisions/Chapters/Members can *"Help Top Issue Action"–* *Need Flow-Up—Flow Down Action***
    - **Communicate *Status/Results* of "Top Issue Actions"**
    - **National Work with Divisions/Chapters to *Include a Top Issue Topic in Meeting/Symposia* (Speakers, Outline of Content etc.)**

Armament Division—Strategic Issues

- **NDIA Impact and Influence: "Top Five" and Sub/Related Topics**
  - **On Membership:**
    - National Defense Magazine
    - Symposia and Conferences
  - **On Congress:**
    - Top Issues
    - Legislative Breakfasts/Luncheons etc.
  - **On DOD:**
    - Policy Statements/Recommendations
    - Special Studies
  - **On Individual Services:**
    - Special Studies
  - **On Programs—Technology:**
    - Symposia Themes and Topics
    - Highlight or Focus on Key Programs or Technologies

Armament Division---Division Activity

- **Strategic Focus Topics-Actions:**
- **Objective: Implement Actions to Enhance Armament Division Effectiveness and Value**

- **Approach:**
  - **Executive Committee Leadership Established List of Topics**
  - **Committee Members Expanded List**
  - **Executive Committee Established "Top 5"**

- **Status and Actions:**
  - **Executive Committees *Established Priority to Symposia Only***
    - **Participation re: Special Tasks etc. by Volunteers Only, not a Committee Responsibility.**
    - ***Implementing "Top 5"* and Related Topics—Open to Others**

Armament Division---Division Activity

Strategic Focus Top Five Actions

Number	Topic	Gun and Missile Committee	G&M Comments	Small Arms Committee	Small Arms Comments
1	Training Element In Symposia	Implemented 2008	Strong Interest Committee participation	Under Discussion – High Interest	Goal to add in 2009
2	Executive Committee Subcommittees	Evolving—Established	Will add focus and depth	Responsibilitie s Outlined—	Will add depth and focus
3	Rigorous Presentation Selection Process	Evolving with some specific criteria	Needs some sort of Metric for selection	Process used- updated to improve	Link with Subcommittee will help.
4	Presentation Review for: Objectives, Conclusion, Impact	Increased Attention and Focus-In Call for Papers etc.	Focus on Presenters to Clarify	Progress but more attention planned-In Call for Papers	Working with Presenters
5	Intra-Divisional Innovation Teams	Topics and Discussions	Committee Volunteers to Work	Topics and Discussions	Committee Volunteers to Work

Armament Division---Division Activity

Strategic Focus Top Five Actions

Number	Topic	Gun and Missile Committee	G&M Comments	Small Arms Committee	Small Arms Comments
6	Committee Mentor—Protégé	Discussed-No Action	Need But No Current Action	Plan to Implement to Grow Leaders	Interest is Strong
7	Symposia Theme Focus	Focus of 2008 Planning	Planning addressed this effectively	Focus on 2008 Planning	Increased Attention
8	Industry Presentation Emphasis vs. Gov't-evolve balance	Message to Industry to Present has been effective	Industry has responded effectively	Balance Improved- Must continue to work	Adding Industry Award and Emphasis of Panels
9					
10					

Armament Division---Division Activity

- **Coordinated Symposia:**

2010 Symposium

- Division Will Implement Coordinated Symposia 2010
  - Gun and Missile System Committee
  - Small Arms Systems Committee
- Format:
  - Common Location
  - Common Week
  - Shared Facility
  - Joint Program Planning Team
  - Concurrent Sessions
    - Each Committee Will Maintain Identity—Separate Meetings
    - Common Sessions Where Beneficial

      Keynotes—

      Common/Shared Technologies

      Training/Education etc.

Attendance

G&MS---350 Annual

SAS---450 Annual

Combined/Joint Est. 500-600

Armament Division---Division Activity

- <u>Collaboration with Sister Divisions:</u>
  - *<u>Significant Opportunity and Potential For Synergism</u>*
  - Divisions of Interest (Partial List—Examples)
    - Fuze
    - Manufacturing
    - Homeland Security
    - Combat Vehicles
    - Robotics
  - Other NDIA Elements:
    - Precision Strike
  - Opportunities Addressed:
    - Coordinate Symposia—Common Location and Time
    - Share Speakers and Program Content

<u>Recommend:</u>
Division Chairs Identify Opportunities for Cooperation And Joint Symposia

NDIA Communications

- National Defense Magazine
  - Emphasis on relevant and timely topics
  - Frequently source of media, DoD, and Congressional reference
- Website
  - Symposium presentations available — attendee access
  - Complementary information
  - Full list of activity
- Top Public Policy Issues — prioritized — addressed to Congress — strengthen the community
- Key Priority Issues/Topics —Addressed to Impact Defense Industry

NDIA Messages and Content Has Impact

and

Website Used Extensively as Resource

NDIA International Symposium Links

Objective: International cooperation and integration of symposiums benefiting industry and Department of Defense to encourage partnerships for development, production, and interoperability

Approach:
- Coordination of NDIA Armament Division programs with “Symposium at Shrivenham” The Royal Military College of Science
- Common presentations and panel participants is a strong “open door” resource

European Small Arms and Cannon Symposium

August 2008

Armament Division Status --- "A Look To The Future"

- **Status in Recent Years**
  - Strong and Growing Attendance in most Symposiums
  - Integration of New Approaches in Symposiums
    - Continued Reliance on Call For Papers vs. Finding the Right Presentations—Executive Committee Actions
  - Generally Positive Comments from Attendees "BUT"
  - Definite Interest in Integrating Content to "ADD VALUE"

- **Looking Ahead**
  - Executive Committee Establish and Implement a Strategic Vision
  - Executive Committee Leadership Initiatives vs. Management of what comes along
  - Establishing Continuous Improvement Approach
  - Ensuring Value Added is Demonstrated in All Meetings
  - Responsive to NDIA Strategic Focus Initiatives

Armament Division 2008 Challenges

- Ensuring Focus on NDIA Mission Statement
  - Strategic Focus Initiatives
- Communicate NDIA Messages and Effectiveness
  - "Branding Impact"—Clarify What is NDIA
- Capturing Symposium Attendee and Membership Topics of Interest in Programs and Activities
- Ensure Membership Awareness of Top NDIA Congressional Issues and Impact
- Seek Symposium and Related Activity which Impact Capability and Responsiveness

Strategic Focus Emphasis

- **Effective Communications and Links Across Government and Industry**

- **Ensuring Innovation in Technology and Systems**

- **Strengthening the Industrial Base —Recognizing the Need**

- **Building an Integrated Team —Industry and Government**

- **Promoting Communication with "Value Added" Content**

Leadership Vision

NDIA Armament Division Is:

- A relevant Voice and Forum--*Enabling Impact to Issues/Topics*
- Meeting NDIA Mission Statements with Strategic Focus
- Responsive to DoD Community and Industry Challenges
- A Forum for DoD/Industry Interaction Discussion of “Lessons Learned” and Needs
- Supporting National Defense through People Resources, Networking, and Symposiums
- Transforming to Ensure Relevance to Changing Military, Geopolitical Environments, Technology, and Industrial Base Resources

The NDIA Community is the Resource of Choice For Excellence in National Defense Topics/Communications

2008 Armament Division Highlights

- Symposium Attendance Strong and Growing

- Symposium Exhibits Effective and Quality Enhanced

- Attention to Strategic Focus Topics Enhances Effectiveness

- Executive Committee activity strengthened an increased

- Government and Industry Partnership in Division leadership demonstrated

Armament Division leadership strength enables strategic focus to address current and future needs

Take-Away Thoughts

- **<u>NDIA Mission</u> is Focused to Strength, Responsiveness and People**
- **NDIA <u>Strategic Focus</u> Committed to Continuous Improvement—**
  - ***<u>"Value Added", Responsive, and Impacting Issues and People</u>***
- **<u>Collaboration of Division Activities</u> Offers Expanded Programs and Symposia Efficiency**
- **Listening to the Symposia <u>Interest of Members</u> is Key to Effective Programs—**
- **<u>Training and Education Segment</u> Address DOD and Industry Changes and Priorities *<u>–PLTW for the Future Workforce</u>***

<u>NDIA Strategic Focus Ensures:</u>
"Value Added" Activity with Impact
Enabling
National Defense Objectives
Through
Systems, Technology and People

Experimental Performance Analysis on Recoil Pad for Reducing Firing Shock Force

NDIA International Infantry & Joint Services
Small Arms Systems Symposium

May 19-22, 2008

Joon-Ho Lee*, Eui-Jung Choe, Je-Wook Chae
Agency for Defense Development, Korea

Jeong-Hoon Kang
S&T Daewoo, Korea

Introduction

□ Recoil (Kick)

✓ Physical property acting on rifle by firing

→ Momentum of rifle = Momentum of projectile + Momentum of powder gases (*Newton's third law of action-reaction*)

✓ Firing shock force (*N*), recoil energy (*J*), impulse ($N \cdot s$)

→ Proportional to powder & gases quantity, exhausting gases velocity, muzzle velocity, projectile mass

→ Inversely proportional to rifle mass

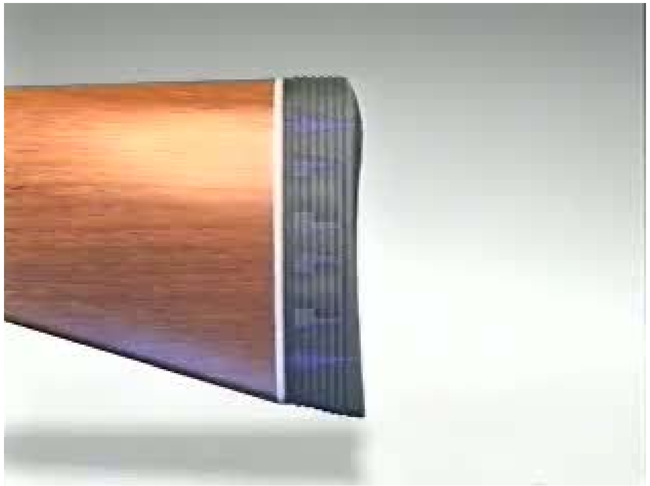
✓ Felt recoil

→ Related to peak pressure on the skin, which is caused by stopping the recoiling rifle

→ Items such as recoil pads, muzzle brakes and shock absorbers are utilized to reduce the amount of felt recoil.

Introduction

- Recoil Pad
  - ✓ Protect shooters from shock and vibration caused by firing.
  - ✓ Minimize recoil transmitted to shooters, which allows them to operate longtime with comfort.
  - ✓ Help shooters to aim at the target and fire precisely.



Research Background

□ Experimental Prototype of New Rifle

- ✓ Shoulder-fired dual barrel weapon system which consists of 5.56 mm and 20 mm caliber barrels
- ✓ However, firing a 20 mm ammunition produces high recoil. → negative impact on the shooting performance
- ✓ To reduce the total weight, recoil pad is used to reduce the high recoil of the weapon so that the soldier can fire the 20 mm ammunition precisely at the target without hesitation.

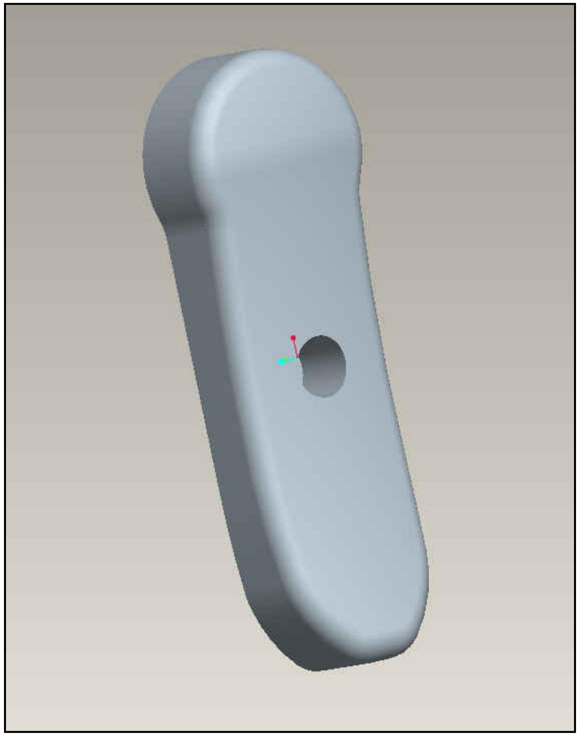
Mockup of New Rifle

Objectives

- □ Test and evaluation of the performance of recoil pads
  - ✓ Criterion : recoil-related firing shock force
  - ✓ Design variable : material property (hardness)

- □ Development of experimental setup for recoil pads
  - ✓ How to measure firing shock force, transmitted through the buttstock and recoil pad, while the rifle being fired on the sliding gun mount

Shape of Recoil Pad to be Tested



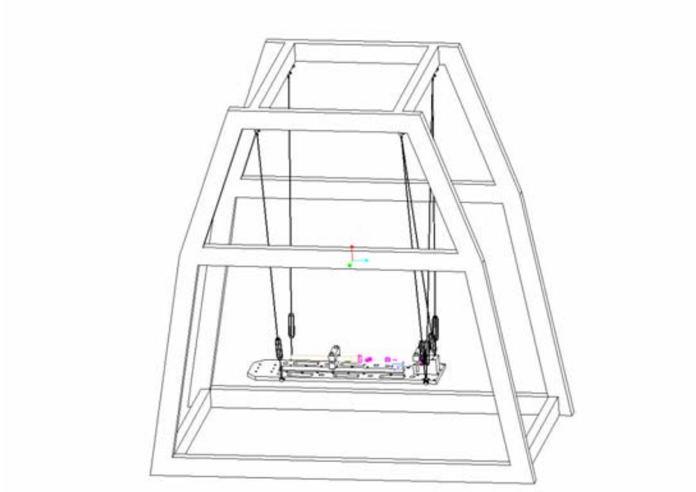
3D ProE Model

Recoil Pad

✓ **Designed and manufactured to be fit for the contour of shoulder area on which the rifle is rested.**

Impulse-Recoil Measurement

- TOP 3-2-826 (kinetic tests for small arms)
  - ✓ Measuring the impulse (I) and recoil energy (E) of small-caliber weapon by means of ballistic pendulum



4 Supports – 6 Wires System

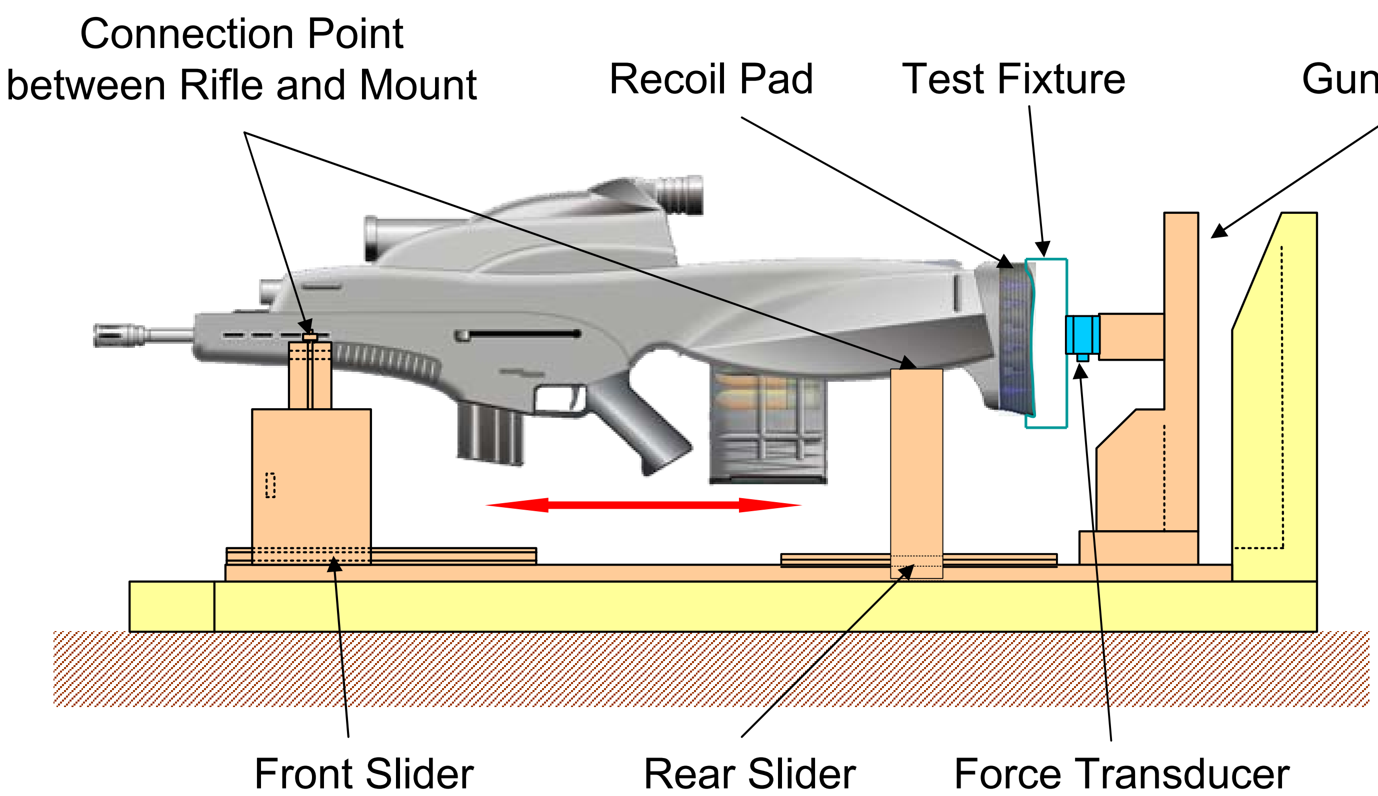
$$I = \frac{2\pi\left(m_{rifle} + m_{cradle}\right)d_0}{T} \quad (N \cdot s)$$

$$E = \frac{I^2}{2m_{rifle}} = \frac{1}{2} m_{rifle} v_{rifle}^2 \quad (J)$$

Intrinsic recoil-related values of rifle (irrespective of recoil pad)

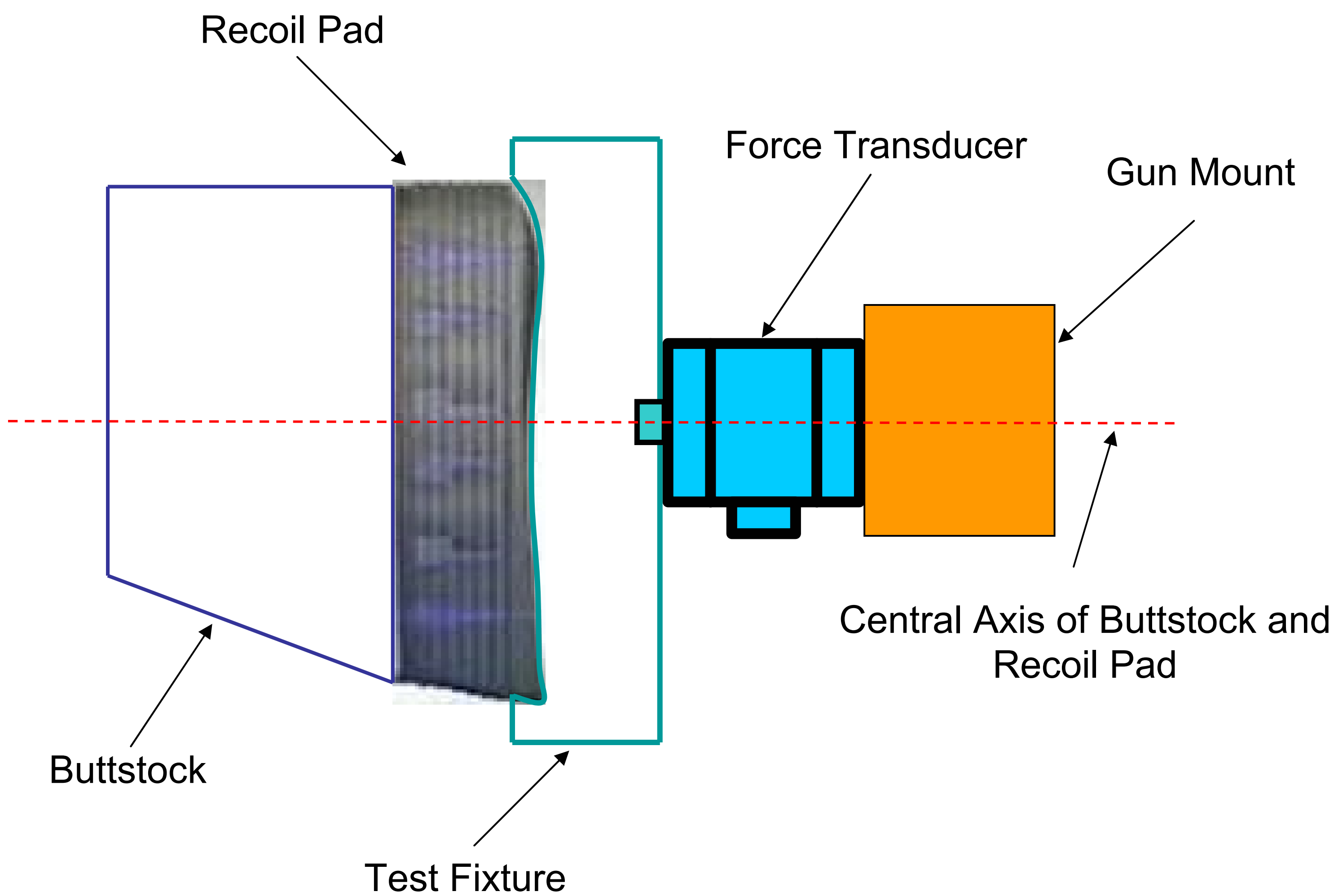
: The performance of recoil pad can not be evaluated by ballistic pendulum.

Experimental Setup with Recoil Pad

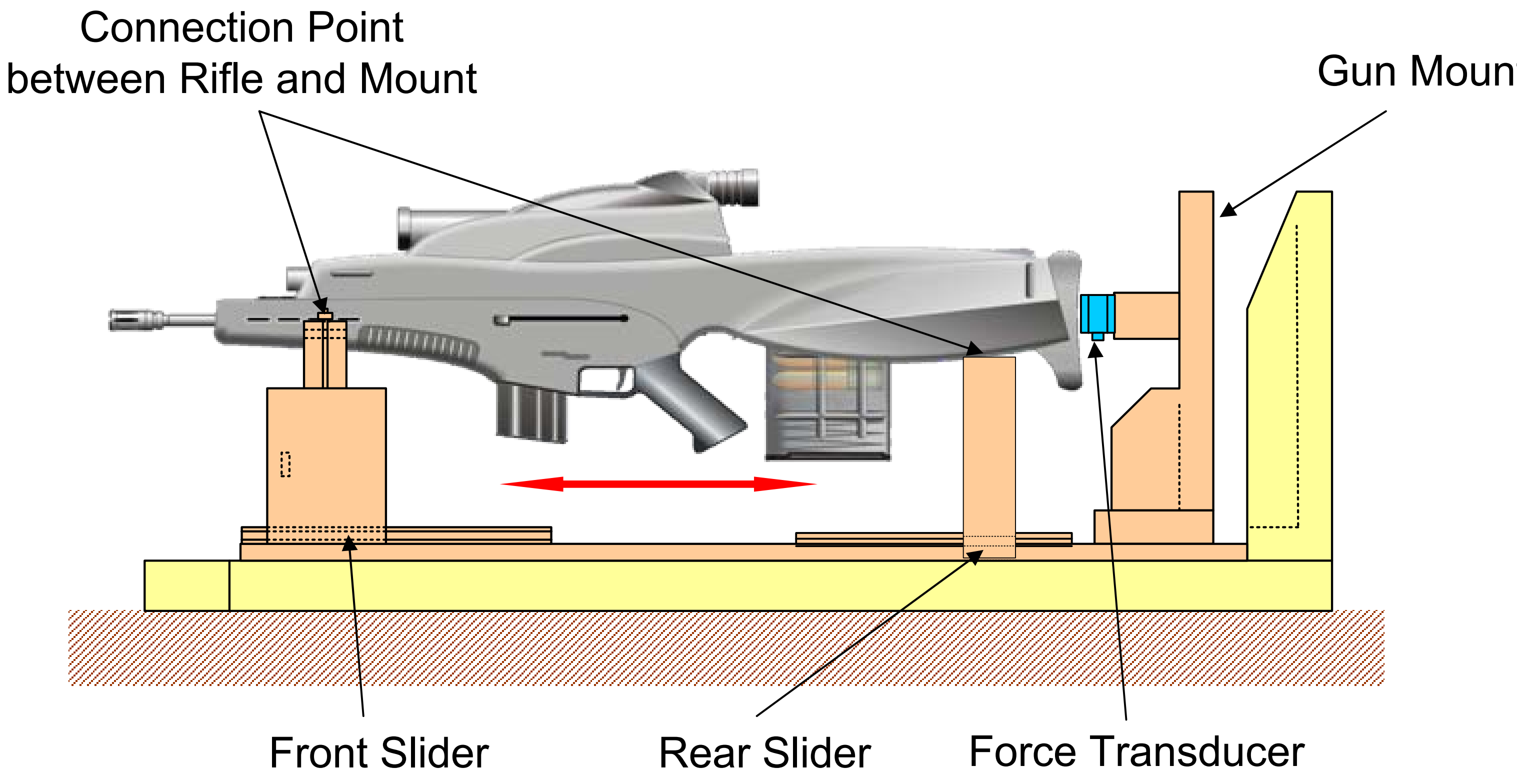


✓ **The rifle moves horizontally on the sliding gun mount.**

Experimental Setup with Recoil Pad

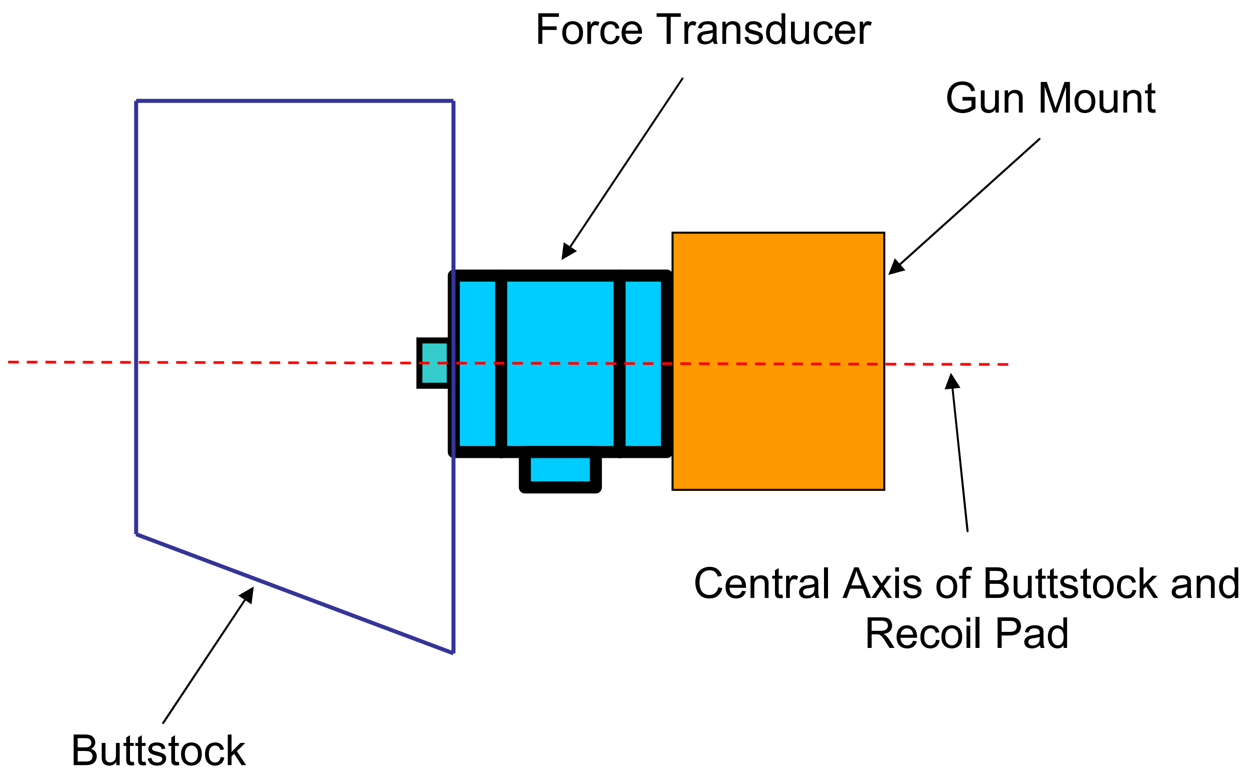


Experimental Setup without Recoil Pad

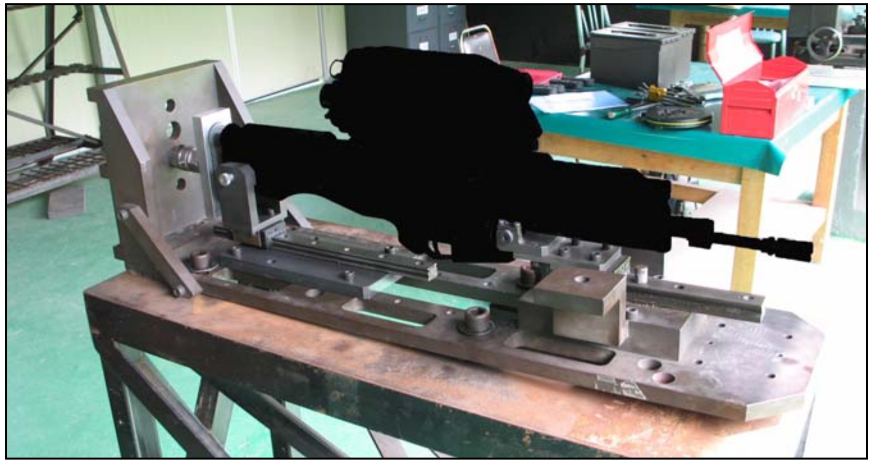


✓ **The rifle moves horizontally on the sliding gun mount.**

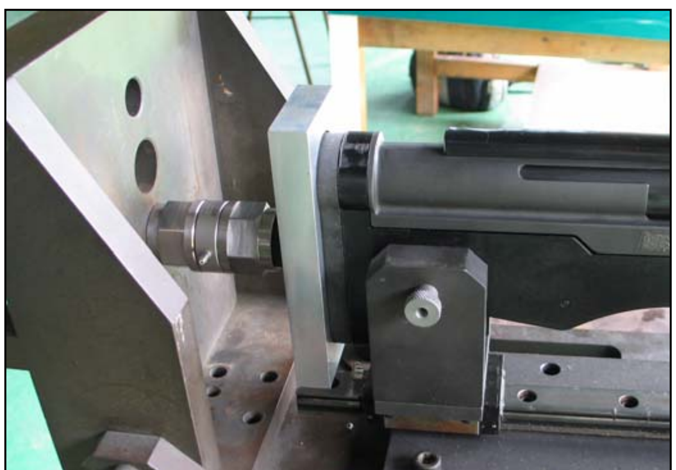
Experimental Setup without Recoil Pad



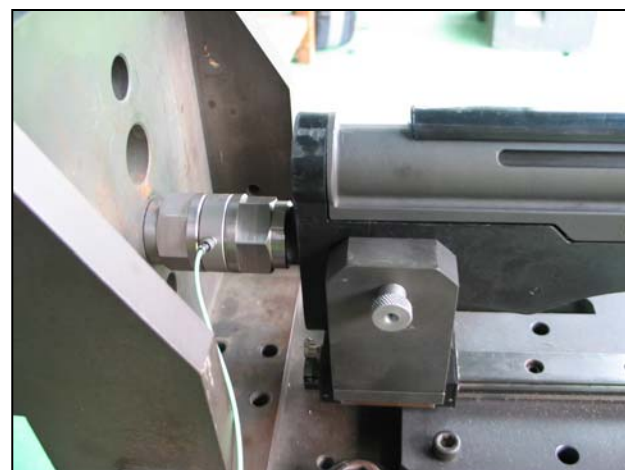
Experimental Setup



Experimental Prototype on the Sliding Gun Mount

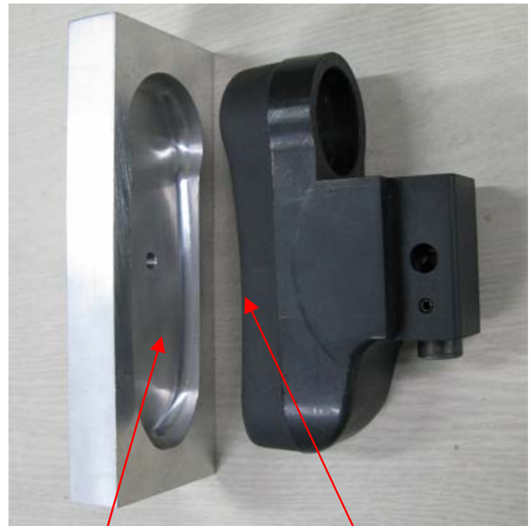


With Recoil Pad



Without Recoil Pad

Experimental Setup



Test Fixture

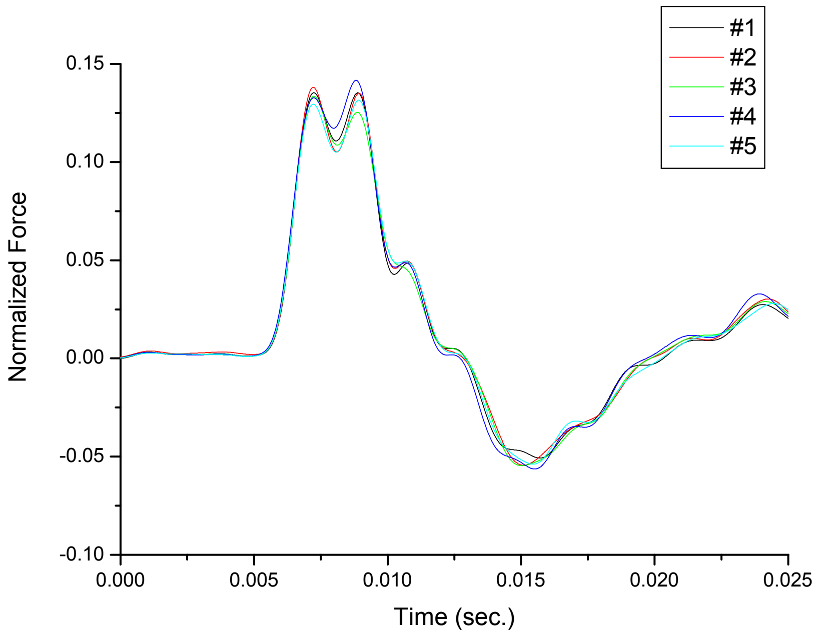
Inner curved surface

Outer curved surface

- ✓ **Material of test fixture : Aluminium**
- ✓ **The inner curved surface of test fixture was manufactured to be perfectly matched with the outer curved surface of recoil pad by using NC machine and 3D contour data from 3D ProE model of recoil pad.**
  → The pressure, exerted by the recoil force, is distributed evenly on the whole contact surface.

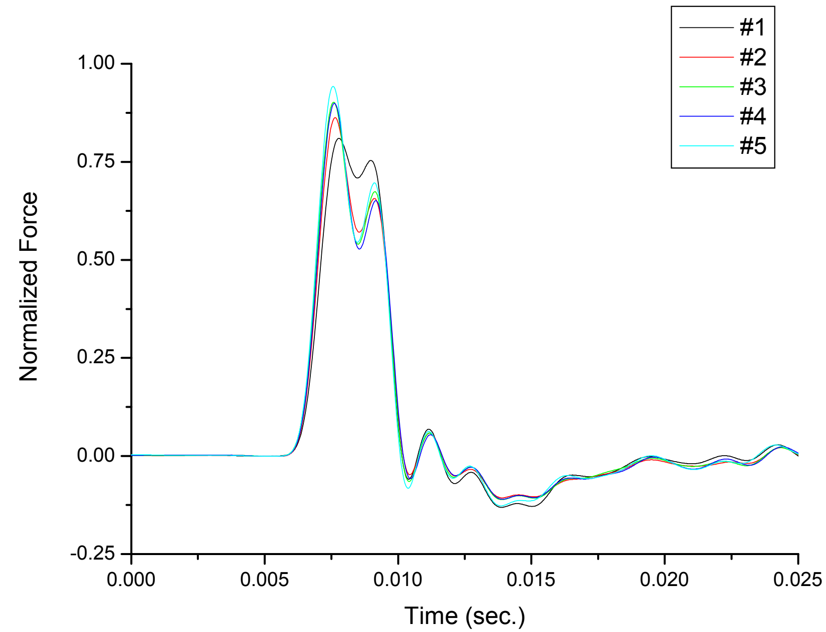
Experimental Results without Recoil Pad

□ Measured Firing Shock Force



In case of 5.56 mm ammunition (5 shots)

Peak firing shock force = 0.136F_{ref}

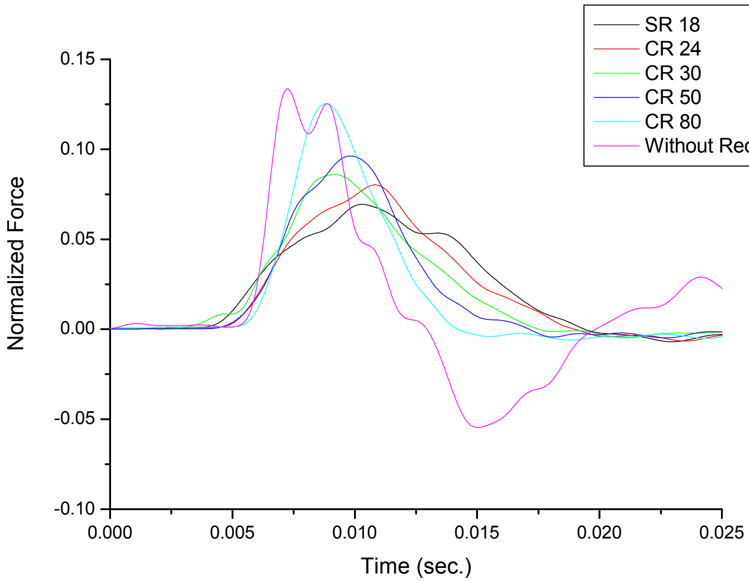


In case of 20 mm ammunition (5 shots)

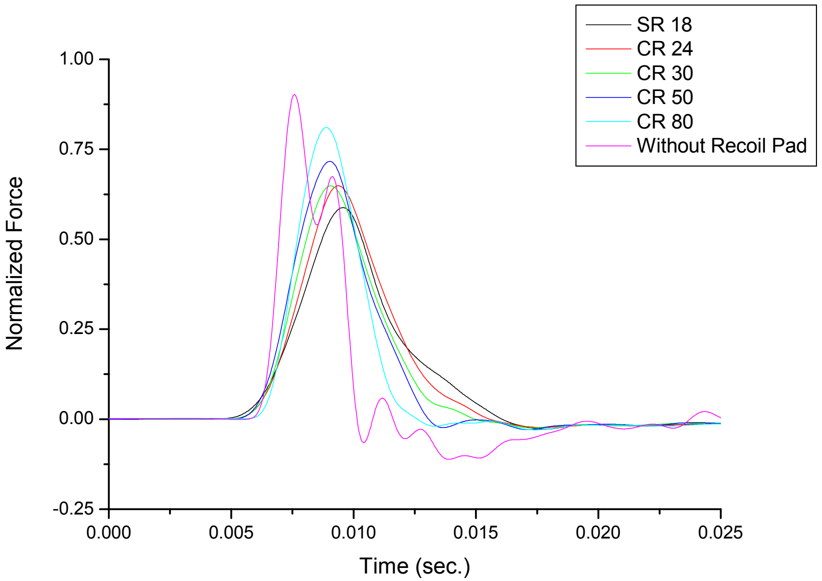
Peak firing shock force = 0.883F_{ref}

✓ **Peak shock force of firing 20 mm ammunition is around 6.5 times higher than that of firing 5.56 mm ammunition.**

Experimental Results with Recoil Pad



In case of 5.56 mm ammunition



In case of 20 mm ammunition

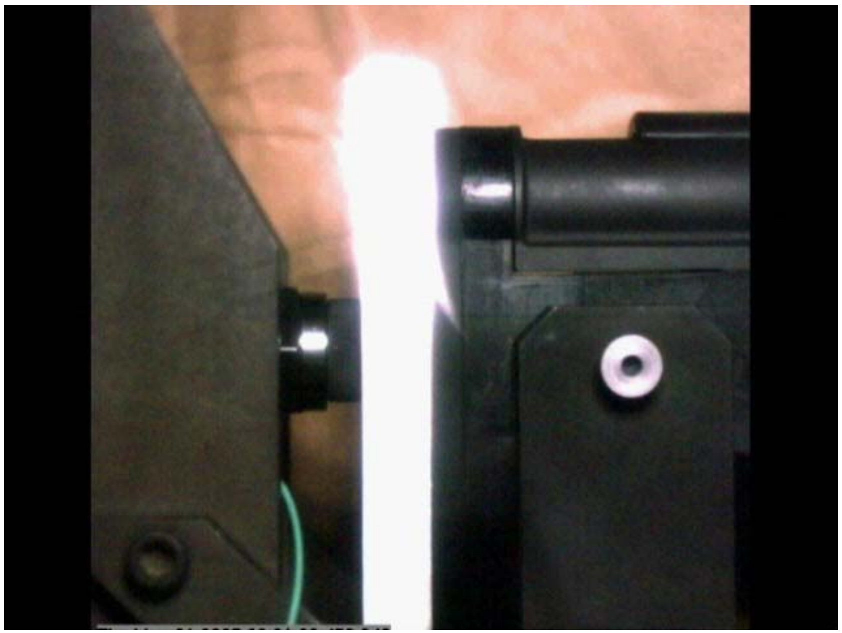
Peak Firing Shock Force (x F_{ref})

Material (Hardness)	SR (Hardness 18)	CR (Hardness 24)	CR (Hardness 30)	CR (Hardness 50)	CR (Hardness 80)	Without Recoil Pad
5.56 mm	0.068	0.081	0.090	0.101	0.121	0.136
20 mm	0.588	0.645	0.689	0.715	0.778	0.883

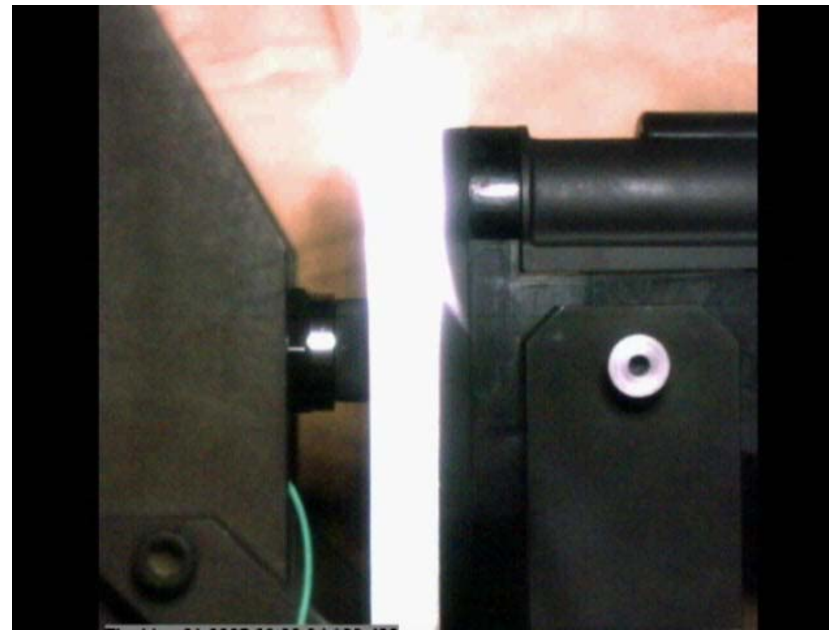
**** SR : Silicone Rubber, CR : Polychloroprene***

Experimental Results with Recoil Pad

- Motion of Recoil Pad by High Speed Camera



In case of 5.56 mm ammunition



In case of 20 mm ammunition

Summary

- □ Effect of the Hardness of Recoil Pad
  - ✓ The performance of reducing firing shock force was increased as the hardness of the recoil pad was lowered.
  - ✓ In case of SR(hardness 18), the peak firing shock force was reduced by 50% in case of 5.56 mm ammunition and 33% in case of 20 mm ammunition, respectively.
- □ Experimental Setup to Evaluate the Performance of Recoil Pads
  - ✓ It can be referred for the test and evaluation of recoil pads which will be attached to shoulder-fired weapon systems with high recoil, developed in the future.

End of Presentation

Thank you very much!

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GENERAL DYNAMICS

Ordnance and Tactical Systems

U.S. SMALL CALIBER AMMUNITION

Second Source Small Cal Program

NDIA Small Arms Systems Symposium

21 May 2008

GD-OTS SECOND SOURCE TEAM - STATUS

- The General Dynamics – Ordnance & Tactical Systems Small Caliber Ammunition (SCA) Team is augmenting the U.S. Government organic base to meet the small caliber ammunition needs for the GWOT.
- The SCA Team is currently executing a multiple year ID/IQ program to deliver in excess of 1B rounds of ammunition.
- Multiple Manufacturing facilities around the world have been qualified to produce small caliber ammunition to U.S. Government specifications.
- A world-wide logistics and shipping organization has been implemented to support CONUS and OCONUS supplies.
- About 400M rounds delivered through to date.

SCA SECOND SOURCE TEAM PRODUCTS

Combat and Training Ammunition

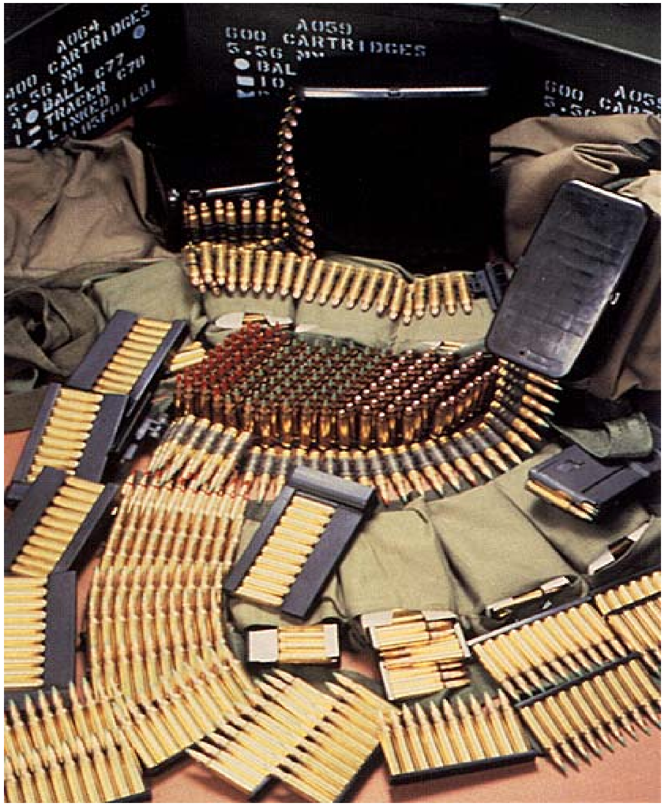
-Ball Clip

-Armor Piercing Incendiary

-Armor Piercing Incendiary with Trace

-Ball/Trace Linked

-Blank



5.56mm
7.62mm
.50 Caliber

SECOND SOURCE LESSONS LEARNED

- A Second Source is a viable strategy for the ammunition base, now and for the future

  Provides critical surge capability
  Eliminates single point failure associated with LCAAP
  Provides needed contingencies to avoid catastrophic supply interruptions

- Existing capabilities and capacities need to be expanded

  Complex logistics challenges associated with moving energetic materials.
  Select foreign sources carefully to meet demand.
  International politics, business and regulations complicate business.

- Tracer capability in all small calibers needs to be expanded.

  Current Second Source supply is International based.

- Government contracts now must reflect the realities of the marketplace – proper commodity price indexes essential in long term, fixed price contracts

  Suppliers in this dynamic market can no longer afford to assume commodity risks – 400% growth in last 3 years.

RESPONSE TO INCREASED NEEDS

- The Second Source supply base has invested into capacity and capability expansion to meet USG demand.
  - 300-500 million round capacity available to support surge requirements.
- Global marketplace includes the USG demand, Foreign Government Demands and the commercial market.
  - Access to capacity is not only driven by obligations to meet GWOT demands, but also Commercial market requirements.
  - Commodities (copper, zinc, lead, fuel, others) are in extreme high demand, driving higher material costs due to supply and demand requirements.
  - SCA Suppliers management of business portfolios allocate capacities based on ability to pass through commodity prices – sometimes limits abilities to meet certain volume/product mix demands.

CHALLENGES & OPPORTUNITIES

- Challenges
  - Proper EPA clauses for commodities that offset record setting growths in USG contracts
  - Adding qualified domestic and international suppliers to increase capacities to meet annual USG volume requirements which compete with commercial demands
  - Managing Global shipping requirements with use of US Flag Vessels
- Opportunities
  - Forecasted on-going Second Source requirements allows for the possibility to expand capabilities and capacities
  - Overcoming the challenges of compliance with USG Specifications enables our international suppliers to modernize operations and improve production capabilities to meet our volume demands

Small Arms System
2008
Symposium

Small Caliber Ammunition
Industry Capability Evolution
And
Readiness

Panel Discussion

21 May 2008

Panel Topic Theme

- **Small Caliber Ammunition Industrial Base Overview**
  - **Status 2008**
  - **“Lesson Learned”**
  - **Significant Demonstrated Response to Needs**
  - **Vision For Future—Ensuring Readiness**
  - **Technology Evolution– Achieving Insertion**
  - **Challenges Re:**
    1. **Maintaining Industrial Base Readiness**
    2. **Selective Introduction of Technology etc.**
  - **Risk Management**

- ***A Discussion of the Small Caliber Ammunition Industrial Base – Past--Today--Future***

Panel Objectives

- Overview Status of Small Caliber Ammunition Industrial Base
- Address Response to Increased Capability Needs Since 2001
  - Impact on Future
- Address Small Caliber Ammunition Industrial Base Capability Vision
  - Current Technology and Products
  - Introduction of Evolving Products
- Outline Challenges for Technology Base and Production Base
- Define, Risks Path Forward Visions, Opportunities

Panel Format and Process

• Panel Opening Comments/Format Description	Moderator
• Panel Member Remarks	Each Member
• Panel Dialogue—Lead by Moderator	All
• Questions from Attendees – Written Questions – Open Format Questions (As Time Permits)	Panel Members
• Concluding Summary Comments	Panel Members
• Wrap-Up Summary	Moderator

Panel Members

Name	Position	Organization
• Dave Broden (Moderator)		
• Keith Enlow		ATK—Lake City
• Steve Torma		GD-OTS
• Bruce Webb		Nammo USA
• Alan Serven		Remington
• Dave Council		Olin

Panel Members

Name	Position	Organization
• Pierre Lemay		GD-OTS Canada
• Paul Shipley		Textron-AAI
• Nick Malkovich		Mac Ammo
• Sy Wiley		Polytech

Topic Categories

- **Small Caliber Industrial Base Status –2008**
- **Small Caliber Industrial Base Response to Need Since 2001**
- **Key “Lessons Learned” and Impact on Future**
- **Vision for Industrial Base Future**
  - **Capability Level Base etc.**
- **Concerns Regarding Future**
- **Barriers to Future Responsiveness and Readiness**
- **Impact of Technology —Configuration Change on Industrial Base Readiness**

Topic Categories

- Tech Base and Related New Technology Funding Addressing User Challenges/Needs vs. Compatibility with Production Resources

- Component Supply Chain Readiness

- Commodity/Material Supply Chain Readiness
  - Sources
  - Availability
  - Cost—Commodity Price Increases/Fluctuations
  - Lead Times

- Critical Items, Barriers etc. To Achieving and Maintaining Desired Readiness

Topic Categories

- **“Lessons Learned” –Technology, Configuration, and Process Needs to Ensure Meeting Warfighter Needs**
  - ***What are the key improvement needs of current products or production? Addressed Yes/No?***

- **“Green Ammunition” Maturity and Production Integration Status**

- **Are Production TDP Improvement and Industrial Base Readiness Considerations Effectively Addressed by Tech Base etc.?**

- **Component and Commodity Readiness and Availability**

Technology and Configuration Change Insertion

- **Objective:** Provide the Warfighter Small Caliber Ammunition Advanced Technology and Configurations which offer:
  - Operational Superiority
  - Address Specific Needs
  - Production Quality, Reliability, and Affordability
  - Logistically Supportable

- **Challenges:**
  - Technology/Configurations Proven Ready for Production
    - Performance
    - Producibility
    - Affordability
  - Industrial Base Planning Addressing Changes
    - Facility Flexibility and Adaptability

Topic Categories

- New Small Caliber Technologies

- New Small Caliber Configurations

- Considerations Impacting Introduction of Product Changes
    - Type of Technology
    - Facility/Tooling Limitations and/or Costs
    - User Acceptance
    - Risks

- “Green” Ammunition Considerations and Impact

- Related Facility Modernization
    - Current vs. New Technology/Cartridges etc.

- Large Primary vs. Small/Specialized Sources

Panel Topics and Questions

- 1. Panel Member Overview of Company Capability and Role In Small Caliber Industrial Base.

- 2. Impact of Need Response 2001-2008 and Future on the Company

- 3. What are the Key Benefits Realized by the Industrial Base?

- 4. What are the Challenges Ahead in Current Small Caliber Ammunition?

- 5. Impact of Potential Production Adjustments?

- 6. Concerns for Future?

Panel Topics and Questions

- 7. What are the New Technologies Evolving?
    - When Available for Production Introduction?

- 8. What are the New Configurations Evolving?
    - When are will New Configuration be Considered?

- 9. Barriers to Introduction of New Technology or Configuration?
    - Technology
    - Existing Tooling/Facility Limitations
    - Costs
    - User Factors

- 10 What Path can Enable New Capabilities?

Panel Topics and Questions

- 11. Impact of “Green Ammunition” Initiatives
- 12. Plant/Facility Modernization Considerations
- 13. Number of Sources
- 14. Role of Small Quantity/Specialized Sources
- 15. Tech Base Funded Technology/New Responding to User Challenges vs. Production Introduction/Compatibility
- 16. Supply Chain
    - Component Supply
    - Material Supply

Symposium Attendee Questions

- Written Questions Prepared During Panel Member Remarks
  - Moderator will Select and Ask Questions

- Open Format Questions From Attendees
  - Following Written Questions

Wrap-Up Comments

- Panel Members Present Wrap-Up Remarks
  - ***Identify Top 2-3 Focus Priorities***

- **Focus on Key Topics**
  - Status Today
  - Evolving Technology Integration
  - Challenges
  - Barriers
  - Opportunities
  - Maintaining Readiness and Evolving Change

- DOD and Service Objectives, Focus, and ***Plans—Challenge and Opportunity for Industry***

- ***Industry Focus Thrusts to Enable Current and Future Small Caliber Ammunition Industrial Base Readiness***

Wrap-Up Comments

- **Observations:**
  - **Government and Industry Partnership Has Responded Effectively Establish Industrial Base Capacity and Readiness**
  - **Vision Forward Must Address “Lesson Learned” to Ensure Responsiveness and Readiness**
  - **Manufacturing Capability and Resource Modernization must be Central Focus**
  - **Integration of New Advanced Technologies and Configurations must be Factor in Industrial Base Vision Planning**
- ***Continued Integration of the User, Developer, and Industrial Base Government and Industry Team is Essential to Enable and Ensure Small Caliber Ammunition Readiness***

Closing Remarks---Technology/Integration/Application

- **Moderator Summary Comments**

- **Thank Panel Members for Participation and Candid Comments**

- **Panel Members will be Available for Discussion**

- **Panel Has Effectively Described Status of Small Caliber Ammunition Technology and Production Readiness—Indentified the Needs—Challenges and Opportunities**

- **Partnership of DOD and Industry is Key to Evolving the Capability**

- **NDIA Offers a Forum for Exchange of Information and Networking to Enable Technology Capability and Readiness Evolution**

Polymer Cased Ammunition

Lessons Learned in the Evolution of Design

Material Selection
Based on a Complex Design of Experiment
Applying all the Rules of Injection Molding

Mold it to Fit The Specification

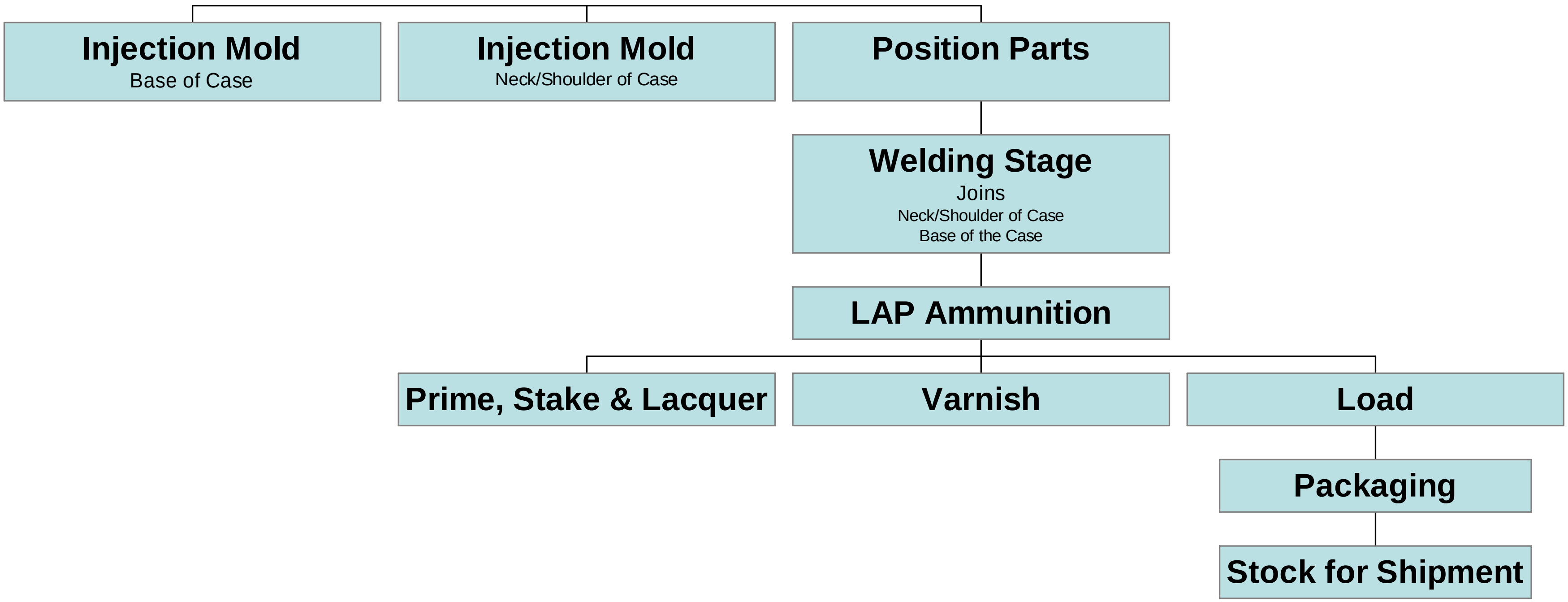
Build it and Bust it!
3rd Party Product Design Verification

Establish Repeatability

Polymer Cased Ammunition

Polymer Cased Ammunition Production is not as Capital Intensive as Brass Ammunition

Production Process



Before reaching the Prime & Stake Stage, Brass takes Significantly More Steps Dependent on the Cartridge

Polymer Cased Ammunition

The "Lessons Learned" over many years of development and the application of key Materials technology has focused this effort . The analysis process (both in house and from partner companies), the evolution of materials technology, and the establishment of process controls has resulted in the achievement of desired performance. At this time a Confirmation of the Design, the Process, and Operational Repeatability is being established.

Polymer Cased Ammunition has now evolved to a point of readiness for qualification and transition to production